PB90-104746

Municipal Waste Combustion Ash and Leachate Characterization Monofill Baseline Year. Woodburn Monofill, Woodburn, Oregon

NUS Corp., Gaithersburg, MD

Prepared for:

Environmental Protection Agency, Washington, DC

Aug 89

U.S. Department of Commerce
National Technical Information Service
NTIS

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. EPA/530-SW-89-074	2.	3. Recipient's Accession No. PB 90 104746 /AS
4. Title and Subtitle MUNICIPAL WASTE COMBUSTION ASH AND LEACHATE CHARACTERIZATION MONOFILL BASE-LINE YEAR - FINAL			5. Report Date AUGUST 1989 6.
7. Author(s) DR. DOREEN STERLING/OSW			8. Performing Organization Rept. No
9. Performing Organization Name and Address U.S. EPA Office of Solid Waste 401 M. Street SW Washington, DC 20460			10. Project/Task/Work Unit No. WA 92 11. Contract(C) or Grant(G) No. (C) (G) 68-01-7310
12. Sponsoring Organization Name and Address NUS CORPORATION 910 CLOPPER ROAD GAITHERSBURG, MD 20872			13. Type of Report & Period Covered FINAL - AUGUST 1989 14.

15. Supplementary Notes

(Office of Solid Waste) (Hazardous and Solid Waste Amendments)

16. Abstract (Limit: 200 words)

OSW requested the assistance of the Risk Reduction Engineering Laboratory in the sampling and analysis of both liquids and solids from a relatively young municipal solid waste combustion residue monofill. The basis for this request is the legislated requirement under HSWA of 1984, dealing with Subtitle D improvements. The Woodburn Monofill, located in Marion County, OR, was selected as the suitable site to provide the needed long-term characterization data of leachates generated from the monofill, of the ashes aging in the monofill, and of the surrounding soils affected by airborne dust from the ash monofill. This report is the first ins a series to be generated from this research effort. It provides base-line data from the first two trips conducted during 1988, the base-line years of the project.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 78
RELEASE UNLIMITED	20. Security Class (This Page) UNCLASSIFIED	22. Price

(See ANSI-Z39.18)

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)

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FINAL

MUNICIPAL WASTE COMBUSTION ASH AND LEACHATE CHARACTERIZATION

MONOFILL BASELINE YEAR

WOODBURN MONOFILL
WOODBURN, OREGON

EPA WORK ASSIGNMENT NUMBER 92
CONTRACT NUMBER 68-01-7310

NUS PROJECT NUMBER 174M

AUGUST 1989

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REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
SPRINGFIELD, VA. 22161

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1.0 INTRODUCTION

The Office of Solid Waste (OSW) has requested the assistance of the Risk Reduction Engineering Laboratory (RREL) in the sampling and analysis of both liquids and solids from a relatively young municipal solid waste (MSW) combustion residue monofill. The basis for this request is the legislated requirement under the Hazardous and Solid Waste Amendments of 1984 (HSWA) dealing with Subtitle "D" Improvements (Section 302 of HSWA).

Past research in this area by RREL has shown that both inorganic and organic pollutants are present in both liquid and solid wastes from MSW combustion residue. Under this project, OSW, with the assistance of RREL, will continue developing a data base on selected constituent concentrations in both liquids and solids from the MSW combustion residue at the selected monofill.

NUS was retained to conduct this study for the Unites States Environmental Protection Agency (EPA) under Contract No. 68-01-7310.

The Woodburn Monofill, located in Marion County, Oregon was selected as the suitable site to provide the needed long-term characterization data of leachates generated from the monofill, of the ashes aging in the monofill, and of the surrounding soils affected by airborne dust from the ash monofill.

This report is the first in a series to be generated from this research effort. It provides base-line data from the first two trips conducted during 1988, the base-line years of the project.

2.0 ENVIRONMENTAL SETTING

The study site selected for the project is the Woodburn Solid Waste Management Facility, which is located in Woodburn, Marion County, Oregon. The portion of the facility selected for study is the ash monofill, referred to as the Interim Ash Landfill. Municipal waste is disposed in separate cells in other areas of the facility. General site conditions are shown on Figure 2-1. Three major operations have occurred, or are still active, on site. These include the following:

- Closed municipal waste landfill in the northwest area.
- Active demolition landfill in the southwest area.
- Ash disposal landfills in the southeast area, consisting of the active Interim Ash Landfill and the constructed, but yet inactive Ash Storage Facility.

The ash disposal of in the Interim Ash Landfill is a combination of bottom ash and fly ash from the Marion County Ogden-Martin facility located in Brooks, Oregon. The Fly Ash is mixed with the bottom ash in the ash quench reactors at the incinerator facility. From there, the ash mixture is discharged onto a large shaker conveyor, travels to where large items are removed, discharged onto a small shaker conveyor, and then discharged onto an inclined conveyor, and then discharged onto an inclined conveyor belt. The ferrous material is removed at the top of the conveyor by a rotating electro-magnet. The ash falls from the inclined conveyor belt onto the ash pile. The ash is loaded onto trucks for transportation to the ash fill. The ferrous material is trucked to a Portland Steel manufacturer, after passing through a trommel where small particles of ash clinging to the metal is removed.

A lime slurry is injected into the flue gas to neutralize acid gases formed in the boiler. The flue gas then passes through the bag houses where the fly ash-lime mixture is removed from the flue gases. This mixture is then transported back to the ash quench reactor where it is mixed with the bottom ash.

The monofill is located between the Willamette and Pudding Rivers near the natural topographic divide between the rivers. The site is drained by an unnamed tributary to Senecal Creek and by Senecal Creek, which discharges to the Pudding River.

SITE LOCATION MAP

GENERAL CONDITIONS
WOODBURN SITE, WOODBURN, OREGON

FIGURE 2-1

0 300 600
SCALE IN FEET

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The site is underlain by the Willamette Silts, which consist of approximately 100 feet of silts, silty sands, and clayey sands. A shallow water table aquifer is present at an average site elevation of 175 feet above mean sea level (MSL). Flow direction is to the west towards Senecal Creek. Average depth to the water table at the natural ground surface elevation on site (180 feet MSL) is 5 feet (R. Fetrow, 1988).

3.0 PROJECT FIELD STUDY

Samples were taken at and around the Woodburn Interim Ash Landfill during three separate field trips. The three trips are identified as follows:

- Trip No. 1, February 11-12, 1988 - Landfill ash leachate and shallow soils sampling.
- Trip No. 1A, May 24-26, 1988 - Landfill ash sampling.
- Trip No. 2, November 29-30, 1988 - Landfill ash leachate and landfill ash sampling.

The field sampling was conducted in accordance with the Work Plan, November, 1987, unless revised per EPA request, or changes needed to be introduced because of field conditions. Any modifications to the Work Plan are described under the description of each sampling trip.

Sampling and analytical procedures were in accordance with the Final Quality Assurance Project Plan (QAPP), February, 1988, which was approved by EPA. Chemical and physical analyses varied with the media type sampled. Specific sample locations and analyses are identified under the description of each sampling trip.

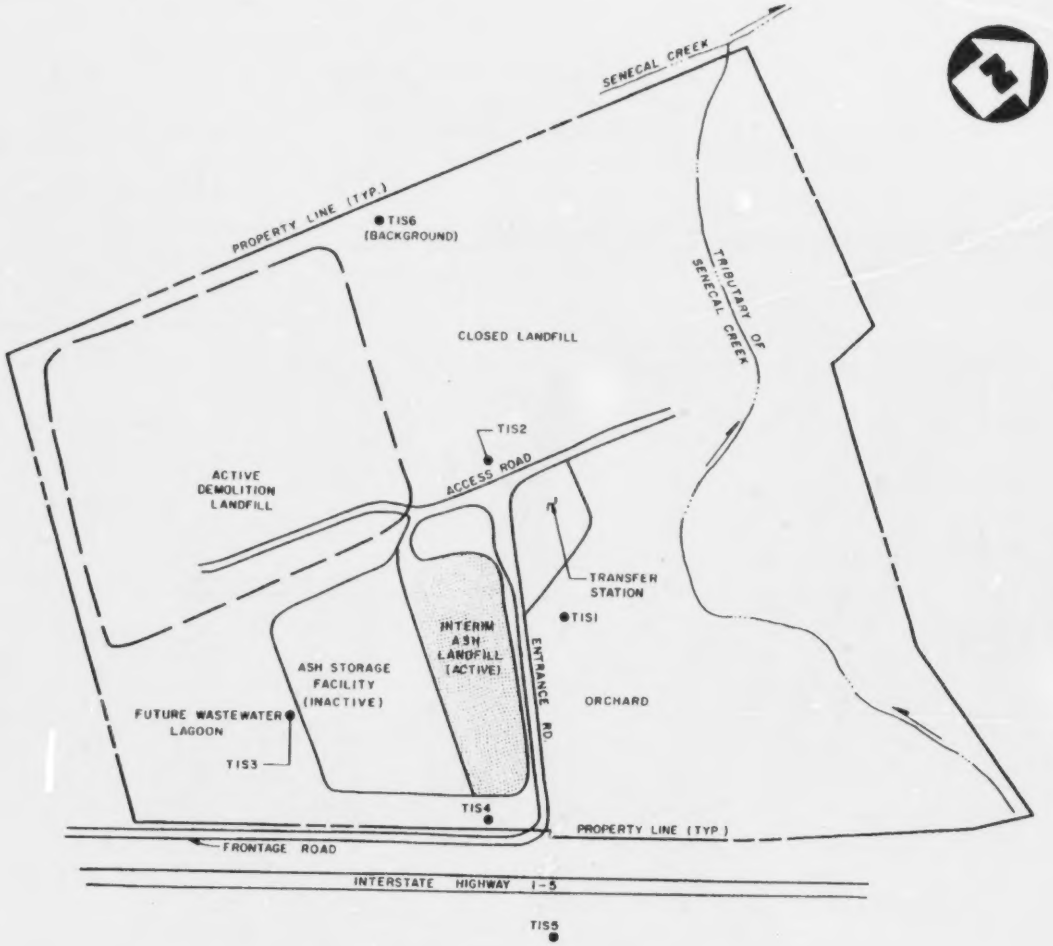
3.1 TRIP NO. 1, FEBRUARY 11-12, 1988

Trip No. 1, to sample landfill ash leachate and shallow soils, was conducted February 11-12, 1988. Figure 3-1 depicts the general site condition on that date, Figure 3-2 depicts the soil sampling locations, and Figure 3-3 depicts the leachate sampling locations.

3.1.1 Site Conditions

The Woodburn Facility at the time of Trip No. 1 consisted of the Interim Ash Landfill, the Ash Storage Facility located directly south, which was under construction; and the contiguous areas within the county property.

The Interim Ash Landfill was constructed by the Marion County Department of Public Works, Solid Waste Division, in 1986. The landfill has a disposal capacity of approximately 51,000 cubic yards and was built with a liner and leachate collection system. The liner consists of a 6-inch thick soil-bentonite mixture overlain with a 6-inch thick native soil cover. Leachate is collected on top of the liner by a



LEGEND

TIS2 ● SHALLOW SOIL SAMPLE LOCATION (0-1 inch depth)

PHYSICAL SITE CONDITIONS AND
SOIL SAMPLE LOCATIONS
WOODBURN SITE, WOODBURN, OREGON

FIGURE 3-1

0 300 600
SCALE IN FEET

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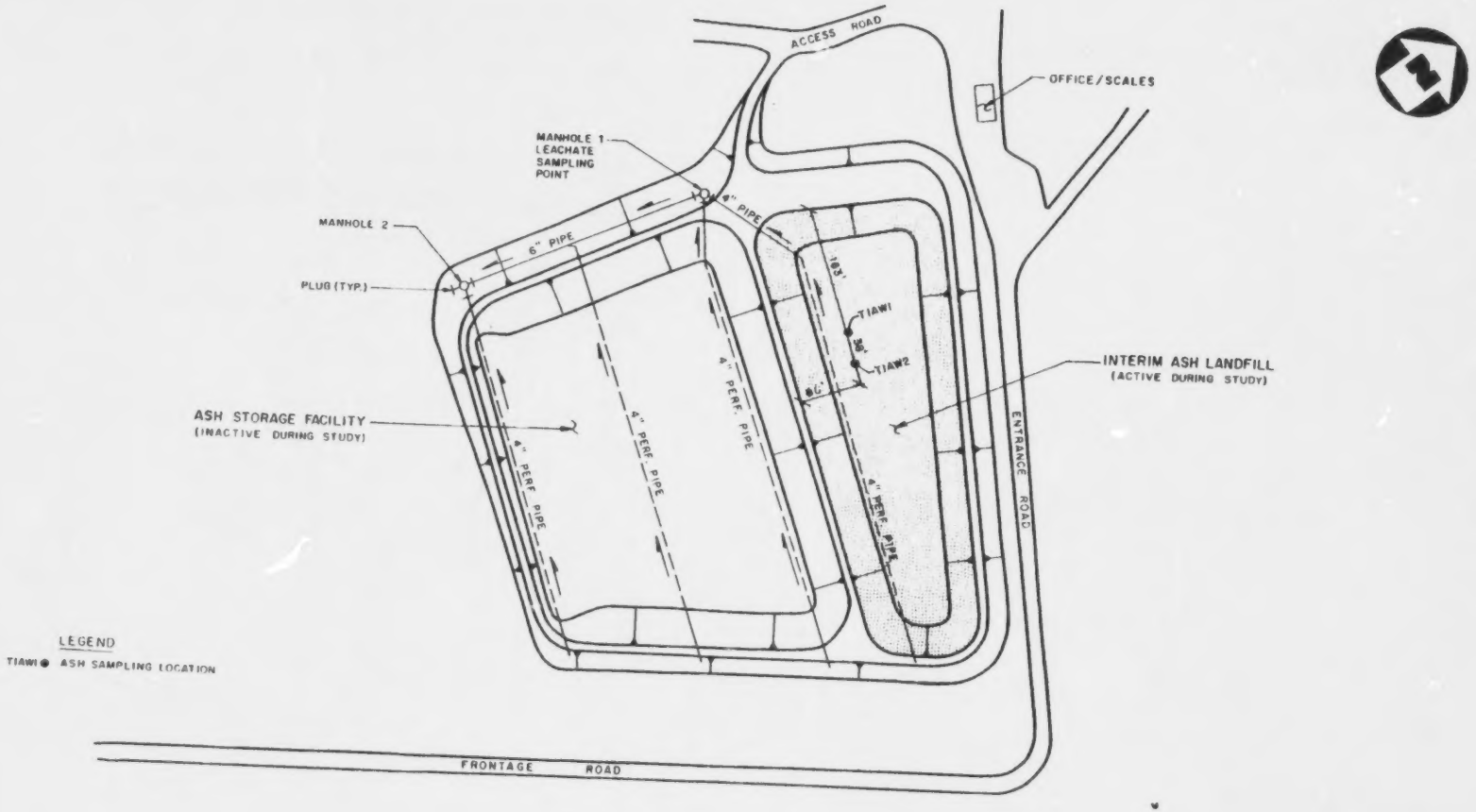


ASH LANDFILL CONDITIONS AND
LEACHATE AND ASH SAMPLING LOCATIONS
WOODBURN SITE, WOODBURN, OREGON

FIGURE 3-2

0 120 240
SCALE IN FEET

NUS CORPORATION

Figure 3-3

coarse aggregate drainage envelope that encloses a 4-inch diameter perforated PVC pipe that conveys liquids to a concrete manhole, referred to as manhole No. 1.

The weather during Trip No. 1 was overcast and foggy, with intermittent light rain. Daily high temperatures were approximately 45°F.

The Interim Ash Landfill (north landfill) was in operation. Filled volume was approximately 80-90 percent of capacity with the remaining capacity at the eastern end. The Ash Storage Facility (south) was constructed, but not in use. The south landfill was filled with approximately 4 to 6 feet of rainwater at the time of the Trip No. 1 site visit.

Leachate from the north landfill was collected by a 4-inch diameter PVC pipe that drains to manhole 1. The 4-inch PVC inlet to manhole 1 was plugged with an inflatable rubber bladder during sampling.

The leachate collection system in the south landfill consists of three 4 inch PVC pipes that are connected as follows:

- To manhole 1 inlet
- To manhole 2 inlet
- To a 6-inch diameter PVC pipe connecting manholes 1 and 2 (via a wye)

The 4-inch leachate inlets from the south landfill to manholes 1 and 2 were plugged. The 6-inch PVC line connecting manholes 1 and 2 was plugged in each manhole. The manhole 2 outlet was also plugged. Therefore, all of the inlets and outlets to each manhole were plugged and any rainwater (south landfill) or leachate (north landfill) generated in the landfills remained stored in the landfills. Additionally, any liquids accumulating in the leachate collection system could not drain out since manhole 2 was plugged.

Site inspection indicated that liquids had accumulated almost to the top of each manhole. This was apparently caused by leakage past the line plugs. Manhole 1 contained the most concentrated leachate since it is directly connected to the active north landfill; however, stormwater leakage from the south landfill might dilute the leachate leaking into the manhole. Manhole 2 contained primarily stored rainwater from the inactive south landfill that had leaked through the line plugs.

The site property around the existing landfills consists of an orchard and undeveloped fields to the north and a closed landfill and an active demolition landfill to the west. The southern property

boundary is along a portion of the demolition landfill; the eastern boundary is at Frontage Road and U.S. Interstate Highway No. 5. The site property surrounding the Interim Ash Landfill, as well as offsite areas to the east, were sampled for shallow soils.

3.1.2 Sampling Plan

The general objectives for the Trip No. 1 sampling were outlined in the Work Plan as follows:

- Collect and measure constituent concentrations in liquids draining from the MSW combustion residue pit (Interim Ash Landfill) at Woodburn, Oregon.

- Collect and measure constituent concentrations of soils in potential particulate fallout areas adjacent to the MSW combustion residue pit at Woodburn, Oregon.

Trip No. 1 samples were analyzed for various inorganic and organic chemical parameters as follows:

Sample Type	Analyses
Leachate	Metals Geochemical Parameters Semi-volatile Organics (Appendix IX) Dioxins (PCDD/PCDF)
Shallow Soils	Metals Dioxins (PCDD/PCDF)

A summary of the Trip No. 1 samples and a description of each sample is presented on Table 3-1. Sample locations are shown on Figures 3-1 and 3-2. Sample analyses results are presented in Section 4.0.

3.1.3 Changes to Work Plan Scope of Work

- Originally, leachate samples were to be obtained from both manholes 1 and 2 (USEPA letter, January 19, 1988).

  Site conditions as of February 11, 1988 indicated that manhole 2 was not an acceptable sample location because the standing water consisted primarily of rainwater (see Site Description, Section 3.1.1). Therefore, manhole 1, which was connected directly to the

TABLE 3-1

TRIP NO. 1 SAMPLE DESCRIPTIONS
WOODBURN SITE

Sample Number	Date	Media	Location (see Figures 3-1 and 3-2)	Description
T1L1	2-11-88	Leachate	Manhole 1 standing liquid.	Black, strong sulfide odor
T1L2	2-11-88	Leachate	Manhole 1, inflow from 4-inch pipe draining north landfill, immediately after plug was removed.	Slightly gray, mild sulfide odor
T1L2	2-11-88	T1L2 MS-MSD	Matrix Spike - Matrix Spike Duplicate.	
T1L3	2-11-88	Leachate	Manhole 1 standing liquids, 1 hour after removing plug from north landfill pipe.	Slightly gray with black, silt-size solids, mild sulfide odor
T1S1	2-12-88	Soil	Shallow soil, 0-1 inches, approximately 200 feet north of the north landfill, in orchard. See logbook page 8 (Appendix A).	Brown, organic silt (vegetation removed)
T1S2	2-12-88	Soil	Shallow soil, 0-1 inches, approximately 200 feet west of site scale house. See logbook page 10 (Appendix A).	Brown, organic silt (no vegetation)
T1S3	2-12-88	Soil	Shallow soil, 0-1 inches, approximately 50 feet south of south landfill. See logbook page 10 (Appendix A).	Brown, organic silt (no vegetation)
T1S4	2-12-88	Soil	Shallow soil, 0-1 inches, between north landfill and Frontage Road. See logbook page 12 (Appendix A).	Brown, organic silt (vegetation removed)
T1S5	2-12-88	Soil	Shallow soil, 0-1 inches, east of Interstate 5 at center of north landfill. See logbook page 11 (Appendix A).	Brown organic silt, some sand and fine gravel (vegetation removed)
T1S6	2-12-88	Soil	Shallow soil, 0-1 inches, approximately 1,000 feet west of north landfill (background sample). See logbook page 10 (Appendix A).	Brown organic silt

north landfill and contained leachate, was considered the only appropriate sampling location.

- Originally, shallow soil samples were to be taken from depths of 1 and 3 inches (USEPA letter, January 19, 1988).

  Sample depths of 0 to 1 inches were considered more likely to contain particulates from the ash pit, if present, then from the 3 inch depth. Uncontaminated soil from deeper depths may dilute the amount of contamination added by the airborne ash particulates.

- USEPA requested that borrow soil sampling and generic liner construction and lab testing be eliminated (USEPA letter, January 19, 1988).

  This activity, Task 3 of the November 30, 1987 Work Plan, was eliminated from Trip 1 and from future tasks.

- NUS added a duplicate liquid sample and a matrix spike duplicate liquid sample for quality control analyses. These samples are indicated as T1L2-MD-MSD, or matrix spike and matrix spike duplicate.

3.2 TRIP NO. 1A, MAY 24-26, 1988

Trip No. 1A was conducted May 24-26, 1988. Figure 3-2 depicts the locations of samples collected during this trip.

3.2.1 Site Conditions

Site conditions at the time of the site visit were similar to conditions during Trip No. 1, except that additional ash had been disposed in the north landfill. The south landfill remained inactive. Weather conditions during Trip No. 1A were sunny and dry. No rainfall had occurred for the previous 3 days. Daily high temperature was approximately 70°F.

3.2.2 Sampling Plan

The Scope of Work for Trip No. 1A was identified in verbal communications between EPA and NUS in May 1988. Trip No. 1A was not included in the original Work Plan.

The general objective for Trip No. 1A was as follows:

- Sample and measure constituent concentrations in MSW combustion ash from the Interim Ash Landfill at a depth of 5 feet at 2 locations.

Trip No. 1A samples were analyzed for physical and chemical parameters as follows:

Sample Type	Analyses
Ash	Grain Size Distribution Metals Semi-volatile Organics (Appendix IX) Geochemical Parameters Dioxins (PCDD/PCDF)

Sample locations were selected to be representative of the "aged" ash near the center of the fill. A sample depth of 5 feet below the active ash fill surface was chosen because it would be representative of average ash age and density. It could also be sampled practically within the capabilities of the excavating equipment.

Samples were taken from the bucket of the backhoe excavation with stainless steel spoons. Fragments larger than 3 inches were physically removed from the ash samples prior to placement of the sample into the containers for shipment to the laboratory for analyses. The ash samples are considered grab samples from the base of the ash excavation.

A summary of the Trip No. 1A samples and a description of each sample is presented on Table 3-2. Sample locations are shown on Figure 3-2. Sample chemical analyses results are presented in Section 4.0.

Sample handling, documentation, and analytical procedures were the same as the applicable procedures used for the soil samples as described in the Quality Assurance Project Plan (QAPP), February, 1988.

3.3 TRIP NO. 2, NOVEMBER 29-30, 1988

Trip No. 2 was conducted November 29-30, 1988. Figure 3-1 depicts the general site condition at that time and Figure 3-2 depicts the location of soil samples and leachate samples collected during Trip No. 2.

TABLE 3-2

TRIP NO. 1A SAMPLE DESCRIPTIONS
WOODBURN SITE

Sample Number	Date	Media	Location (see Figure 3-1)	Description
T1AW1	5-25-88	Ash	Interim Ash Landfill (north), 88 feet north and 163 feet east of the southwest corner of the landfill berm. Depth was 5 feet below ash fill surface.	Field classification was not performed. Ash sample was segregated by hand to remove fragments smaller than 3 inches.
T1AW2	5-25-88	Ash	Same as above, but location was 88 feet north and 201 feet east of the southwest corner of the landfill berm.	Same as above.

3.3.1 Site Conditions

The weather during Trip No. 2 was partly sunny and mild with a daily high temperature of approximately 50°F. Marion County personnel reported that continuous light rainfall had occurred over the previous 30 days.

The original ash landfill (north) was in operation. The new ash landfill (south) was constructed and had a soil cover over the liner; however, no ash has been placed in the landfill. Standing water was also not visible in the south landfill.

The landfill drainage system had not been modified since Trip No. 1 (see Section 3.1.1). The drainage plugs were present in manholes 1 and 2 as they were during Trip No. 1, therefore, all of the inlets and outlets to each manhole were plugged and any rainwater (south landfill) or leachate (north) generated remained stored in the landfills.

Manhole 1 contained approximately 2 feet of standing liquids (approximately 5 feet freeboard) upon initial inspection. This liquid had apparently accumulated from leakage around the pipe plugs. It was noted that during Trip No. 1, manhole 1 was overflowing. This difference in accumulated liquid is apparently related to the saturated level in the landfill, which is subsequently an effect of antecedent moisture conditions. Trip No. 1 took place in February 1988 and followed the wet season. Trip No. 2 took place after the summer dry season.

3.3.2 Sampling Plan

The Scope of Work for Trip No. 2 was outlined in the Work Plan for the leachate sampling and in verbal communications between EPA and NUS for the ash sampling. Ash sampling was not included in the Work Plan for Trip No. 2.

The general objectives for Trip No. 2 were as follows:

- Collect and measure constituent concentrations in liquids draining from the MSW combustion residue pit (Interim Ash Landfill) at the same locations sampled during Trip No. 1.

- Sample and measure constituent concentrations in MSW combustion ash from the Interim Ash Landfill at the same locations sampled during Trip No. 1A.

Trip No. 2 samples were analyzed for physical and chemical parameters as follows:

Sample Type	Analyses
Leachate	Metals Geochemical Parameters Semi-volatile Organics (Appendix IX) Dioxins (PCDD/PCDF)
Ash	Grain Size Distribution Metals Semi-volatile Organics (Appendix IX) Geochemical Parameters Dioxins (PCDD/PCDF)

Ash sampling procedures for Trip No. 2 were modified from Trip No. 1A to allow better characterization of the ash. The ash sample taken at each location consisted of a composite from three locations within the 5-foot deep excavation. Equal volumes of ash were taken from the following locations and mixed in the field to make the composite sample:

- Base of ash excavation, depth of 5 feet
- Wall of ash excavation at a depth of 18 inches
- Surface of spoil pile of excavated ash

A summary of the Trip No. 2 samples and a description of each sample is presented on Table 3-3. Sample locations are shown on Figure 3-2. Sample chemical analyses results are presented in Section 4.0.

Sample handling, documentation, and analytical procedures were the same as the applicable procedures used for leachate or solid samples (soil), as described in the QAPP, February, 1988.

The leachate samples were all taken from manhole No. 1 as they were duringTrip No. 1.

TABLE 3-3

TRIP NO. 2 SAMPLE DESCRIPTIONS
WOODBURN SITE

Sample Number	Date	Media	Location (see Figure 3-2)	Description	Field pH S.U.	Temperature °C
T2L1		Leachate	Sample not taken during Trip No. 2			
T2L2	11-29-88	Leachate	Manhole 1, inflow from 4 inch pipe draining north landfill, after plug was removed and manhole refills to 5 feet freeboard (20 minutes).	Cloudy, gray, with suspended solids, no odor	7.3	13.2
T2L3	11-29-88	Leachate	Manhole 1 standing liquids, 1.5 hours after removing plug from north landfill pipe.	Slightly cloudy, few suspended solids, no odor	7.9	19
T2W1	11-30-88	Ash	Interim Ash Landfill (north) same location as T1AW1 (see Table 3-2).	Dark gray, silt size with sand and gravel-size particles	9.1[a]	19[b]
T2W2	11-30-88	Ash	Interim Ash landfill (north) same location as T1AW2 (see Table 3-2).	Dark gray, silt size with sand and gravel-size particles	8.9[a]	18[b]

(a) Field pH measured by mixing 500 ml of local tap water (pH 7.6) with 500 ml of ash, reading equilibrium at 30 seconds.
(b) Ash temperature is average of 3 readings at base of test pit excavation.

4.0 STUDY RESULTS

The Woodburn Site Study consisted primarily of the chemical characterization of ash and leachate from the active Interim Ash Landfill in Woodburn, Oregon. Physical analysis was performed on ash samples to determine the grain size distribution.

Samples were analyzed by commercial laboratories that were selected based on their demonstrated capabilities to meet the analytical quality control requirements outlined in the QAPP, February, 1988. A summary of the analytical methods and laboratory used for each sample type is presented on Table 4-1. The laboratories adhered to the analytical protocols described in the QAPP, as approved by EPA QC officer on January 25, 1988 (PQ-220-C). The laboratories were audited by an EPA contractor and only upon approved audit reports were laboratories sent samples for analysis.

Analytical results and QA/QC information supplied by each laboratory were subjected to validation. The validation was done by NUS chemists who followed the EPA National Functional Guidelines for validating organics, inorganics, and dioxins. All data were found acceptable.

This section describes the analytical results for all samples taken during the project study.

4.1 LEACHATE

Leachate samples were obtained from the Interim Ash Landfill leachate collection system during Trips Nos. 1 and 2. Three samples were taken during Trip No. 1, and two samples were taken during Trip No. 2. Sample locations and descriptions are contained in Section 3.0.

4.1.1 Metals

Results of metals ana'yses for leachate are shown on Table 4-2. For comparison purposes, this table also includes maximum acceptable metal concentrations for drinking water, surface water quality, and the EP-toxicity Maximum Allowable Limits. Although these reference concentrations are not necessarily appropriate for the Woodburn ash disposal site, they do provide a general indicator for assessment of leachate quality and potential impacts on groundwater and surface water.

TABLE 4-1

ANALYTICAL METHOD SUMMARY
WOODBURN SITE

Sample Media	Analysis Type	Analytical Method	Laboratory
Leachate	Metals		S-Cubed, LaJolla, CA
	Arsenic	SW-7060	
	Cadmium	SW-7131	
	Chromium	SW-7191	
	Copper	SW-7210	
	Iron	SW-7380	
	Lead	SW-7421	
	Manganese	SW-7460	
	Mercury	SW-7470	
	Nickel	SW-7520	
	Selenium	SW-7740	
	Zinc	SW-7950	
Leachate	Conventional		NUS, Pittsburgh, PA
	Ammonia (N)	350.2	
	Total Organic Carbon	415.1	
	Chloride	325.3	
	Kjeldahl Nitrogen	351.3	
	Sulfate	375.4	
	pH	150.1	
	Dissolved Solids	160.1	
	Conductance	120.1	
	Alkalinity	SM 403	
	Nitrate (N)	353.2	
	Phosphorus	365.2	

TABLE 4-1
ANALYTICAL METHOD SUMMARY
WOODBURN SITE
PAGE TWO

Sample Media	Analysis Type	Analytical Method	Laboratory
Leachate	Semi-Volatiles (Appendix IX)	SW-8270	S-Cubed, LaJolla, CA
Leachate	Dioxin	High resolution gas chromatograph high resolution mas spectrometry	Battelle, Columbus, OH
Soil	Metals	Same as leachate analysis, except for mercury, which used Method SW-7471.	S-Cubed, LaJolla, CA
Soil	Dioxin	High resolution gas chromatography-high resolution mass spectrometry	Battelle, Columbus, OH
Ash	Metals	Same as soils.	S-Cubed, LaJolla, CA
Ash	Semi-Volatiles (Appendix IX)	SW-8270	S-Cubed, LaJolla, CA
Ash	Elemental		NUS, Pittsburgh, PA
Ash	Dioxin	High resolution gas chromatography-high resolution mass spectrometry	Battelle, Columbus, OH
Ash	Grain Size Distribution	ASTM D422-63	NUS, Pittsburgh, PA

TABLE 4-2

LEACHATE METALS ANALYSES
TRIPS 1 AND 2
WOODBURN SITE

Sample Number:	T1L1	T1L2	T1L3	Laboratory Blank 1	T2L2	T2L3	Laboratory Blank 2	EP Toxicity Maximum Allowable Limit µg/l	Safe Drinking Water Act[a] MCLs µg/l	Ambient Water Quality Criteria[b] µg/l
Location:	Manhole (1) Standing Liquid	Manhole (1) After Removal of Standing Liquid	Manhole (1) 1 Hour After Standing Liquid Removal		Manhole (1) Immediately After Manhole Refills (20 minutes)	Manhole (1) 1.5 Hours After Removing Plug and Manhole Refills (20 minutes)				
Matrix: Date Sampled: Date Analyzed: Units:	Water 02/11/88 02/21/88 µg/L	Water 02/11/88 02/21/88 µg/L	Water 02/11/88 02/21/88 µg/L	Water 02/21/88 µg/L	Water 11/29/88 01/03/89 µg/L	Water 11/29/88 01/03/89 µg/L	Water µg/L			
Arsenic	160	130	140	10	260	400		5,000	50	360
Cadmium		1.7	1.1					1,000	10	30
Chromium	8	32	18		16	22		5,000	50	7,000
Copper									NA	100
Iron	3,400	650	120	330	2,400	1,600			NA	NA
Lead	11	24	25		54	42	20	5,000	50	800
Manganese	4,600	310	370		1,230	800			NA	NA
Mercury								200	0.2	2.4
Nickel									NA	1,400[c]
Selenium	120	120	130	8	260	340		1,000	10	300
Zinc	370	250	190	100	130	60	40		NA	500

Blank space indicates analysis is below detection limits.
NA Not applicable.
(a) Primary Drinking Water Standards.
(b) AWQC for protection of freshwater biota.
(c) Nickel value based on a hardness of 100 mg/l in the receiving stream.

The metals analyses indicate that arsenic, chromium, iron, lead, manganese, selenium, and zinc were present above the method detection limit in all of the five leachate samples taken during the study. Cadmium was found above the detection limit in only two of the five leachate samples analyzed, while copper, mercury, and nickel were not present in any of the leachate samples at levels which exceeded the detection limits.

All metal concentrations in all leachate samples were below the EP-toxicity Maximum Allowable Limit.

Although leachate samples are not consumed for drinking purposes, the metals concentrations were compared to the drinking water reference data. This comparison indicate that arsenic, lead, and selenium exceed the maximum contaminant levels (MCLs). Arsenic and selenium were consistently the highest metal concentrations relative to the drinking water standards. Lead exceeded the primary drinking water standard in only one of the five samples analyzed.

All other metals were either significantly below drinking water standards (mercury) or did not have a reference standard (copper, iron, manganese, nickel, and zinc). In the case of copper and nickel, both of these metals were below detectable limits in all of the samples taken.

The metals levels in leachate were also compared to the acute Ambient Water Quality Criteria (AWQC). Arsenic and selenium were the only metals that exceeded existing AWQC acute concentrations. Each of these metals exceeded the AWQC in one of the five samples taken.

Trends were observed in certain metals concentrations based on the time the sample was taken from the manhole. For both trips, sample point L3 was expected to represent leachate draining from the ash fill and not from the leachate collection system, based on the volume of liquid purged prior to sampling. Samples L1 and L2 represent leachate stored in the collection system.

Iron, manganese, and zinc showed the most evident trend which was also consistent for both of the sampling trips. Concentrations of these three metals decreased with increasing time after drainage of the leachate collection manhole. The highest concentrations found for these metals were in sample T1L1, which was the standing liquid in manhole 1. The concentrations of iron and manganese decreased by an order of magnitude after the manhole was purged and samples were taken from the landfill drainage pipe. The relatively high iron, manganese, and zinc concentrations in the standing liquid were not confirmed during Trip No. 2, since sample T2L1 was not taken. These metal concentrations are suspected to be caused by leaching of the metal manhole materials, which include

the inside steps and cover. The samples taken after purging of the manhole were from the landfill drainage pipes and are expected to be more representative of leachate quality.

The most significant decreases in sample iron, manganese, and zinc concentrations were between the standing water sample (L1) and the sample taken after purging the manhole (L2). The third sample (L3) was taken after approximately 1 to 1-1/2 hours of draining the leachate collection system pipe. The metals concentrations in this sample were the lowest of all three samples. The relative percent decrease between the second and third sample (L2 and L3) concentrations was significantly lower than between the first and second samples (L1 and L2), however, a constant or equilibrium concentration level was not observed. Confirmation of sample L3 as representative of ash leachate concentration for iron, manganese, and zinc, was not possible since these metals did not reach equilibrium concentrations during the sequential purging sampling. These data suggests that these metals are not distributed uniformly within the landfill leachate environment and their concentratiosn might be dependent on the leachate residence time within the ash fill.

Arsenic, cadmium, chromium, copper, lead, mercury, nickel, and selenium did not demonstrate significant concentration trends with sample time; therefore, equilibrium concentrations appear to have been achieved for these metals based on the consistent concentration levels.

Sample concentrations from Trip Nos. 1 and 2 were assessed for comparability. The same set of metals was detected in each sampling trip, with the exception of cadmium, which was found at low levels in Trip No. 1 and was not detected in Trip No. 2. The metals concentrations varied from Trip No. 1 to Trip No. 2 with the Trip No. 1 concentrations being slightly lower than Trip No. 2 for all metals at comparative sample points, with the exception of chromium and zinc which were slightly higher during Trip No. 1.

4.1.2 Conventional Analyses

Conventional analyses for leachate are shown on Table 4-3. As with the metals results, this table includes available reference concentrations for certain conventional parameters. The reference data for the conventional data are limited, since drinking water standards and AWQCs are not available for most of the conventional parameters of the chemicals analyzed.

The conventional parameter analyses indicate that, generally, the leachate is high in dissolved solids and organic carbon, nitrogen, and ammonia are present.

The concentration range of dissolved solids and major anions (chloride and sulfate) in the leachate is compared to the reported average TDS, chloride and sulfate concentrations in sea water (Hem, 1986).

TABLE 4-3

LEACHATE CONVENTIONAL ANALYSES
TRIPS 1 AND 2
WOODBURN SITE

Sample Number:	T1L1	T1L2	T1L2 (Duplicate)	T1L3	T2L2	T2L3	Reference Data	
Location:	Manhole (1) Standing Liquid	Manhole (1) After Removal of Standing Liquid	Duplicate of T1L2	Manhole (1) 1 Hour After Standing Liquid Removal	Manhole (1) Immediately After Manhole Refills (20 minutes)	Manhole (1) 1.5 Hours After Removing Plug and Manhole Refills (20 minutes)	Primary and Secondary Drinking Water Quality Standards	Ambient Water Quality Criteria[b]
Matrix: Date Sampled: Date Analyzed:	Water 02/11/88 02/21/88	Water 02/11/88 02/21/88	Water 02/11/88 02/21/88	Water 02/12/88 02/21/88	Water 11/29/88 01/03/89	Water 11/29/88 01/03/89		
Ammonia - Distilled (as N)	35 mg/l	23 mg/l	25 mg/l	26 mg/l	5.5 mg/l	5.3 mg/l	NA	17.6mg/l[c]
Organic Carbon	53 mg/l	77 mg/l	73 mg/l	110 mg/l	17 mg/l	23 mg/l		
Chloride	22,000 mg/l	17,000 mg/l	16,000 mg/l	18,000 mg/l	7,700 mg/l	8,300 mg/l	250 mg/l	860 mg/l
Nitrogen, Kjeldahl	43 mg/l	34 mg/l	34 mg/l	38 mg/l	Not Analyzed	Not Analyzed		
Sulfate (SO_4)	1,000 mg/l	1,500 mg/l	1,400 mg/l	1,500 mg/l	1,000 mg/l	700 mg/l	250 mg/l	
pH	6.7	6.9	7.3	7.2	7.4	6.7		
Solids, Dissolved @ 180°C	41,000 mg/l	29,000 mg/l	31,000 mg/l	32,000 mg/l	13,700 mg/l	16,300 mg/l	500 mg/l	
Specific Conductance @ 25°C	46,000 µmhos/cm	33,000 µmhos/cm	33,000 µmhos/cm	38,000 µmhos/cm	Not Analyzed	Not Analyzed		
Total Alkalinity	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	68 mg/l	44 mg/l		
Nitrate (as N)	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	0.2 mg/l	0.2 mg/l	10 mg/l	
Phosphorus	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	0.18 mg/l	0.19 mg/l		

NA Not Applicable
(a) Primary Drinking Water Standards
(b) AWQC for protection of freshwater biota
(c) Ammonia (N) value based on receiving stream at 15°C and pH of 7
Blank spaces indicate standards are not available at this time

COMPARISON OF LEACHATE WITH SEAWATER

Parameter	Leachate Concentration mg/l	Sea water Concentration mg/l
Dissolved Solids	13,700 - 41,000	35,000
Chloride	7,700 - 22,000	19,000
Sulfate	700 - 1,500	2,700

The data presented in this table indicate that the leachate concentrations range from a third the values in sea water to values which exceed levels found in seawater. The levels of TDS, chloride and sulfate found in the leachates collected from the Woodburn Site are similar to levels reported in the literature for other monofills (EPA, 1987 and EPA, 1988).

Available reference data include a drinking water standard of 500 mg/l for dissolved solids of 250 mg/l for sulfate and 250 mg/l for chloride, and an acute AWQC for chloride of 860 mg/l. For all of the leachate samples, the dissolved solids and sulfate and chloride concentrations significantly exceed these reference levels.

The presence of nitrogen species and total organic carbon (TOC) in the leachate suggest the presence of uncombusted organic matter in the ash landfill. Ammonia-nitrogen has been found in all of the leachate samples at concentrations ranging from 5.3 to 35 mg/l. This compound is a typical by-product of anaerobic bacterial decomposition of organic matter and is a known constituent of leachates from sanitary landfills (Chian and DeWalle).

Ammonia-nitrogen is typically not present, or is present at very low levels, in natural waters because in the presence of oxygen, it is not stable and is readily oxidized to nitrate. While ammonia was present in these leachate samples, nitrate levels in the leachate samples were very low. These low nitrate levels indicate that leachate oxidation is not significant in the ash landfill which further supports the theory of the presence of a reducing, anaerobic environment in the landfill.

Leachate TOC levels ranged from 17 to 100 mg/l and averaged 59 mg/l. The average TOC level in rivers of temperate climate zones has been reported to be 3 mg/l (Hem). Reference data are not available for TOC in drinking water; however, the acute AWQC ammonia-nitrogen concentration is reported at 17.6 mg/l which is exceeded in four of the five leachate samples analyzed.

The time sequence of the samples during each trip did not indicate any notable trends in the concentrations of the conventional parameters.

Sample concentrations were not comparable for each trip. Trip No. 2 sample concentrations were typically lower than Trip No. 1, which might be attributable to dilution. Trip No. 1 took place after a long period of lack of rain, during which concentrations of these conventional parameters may have increased. The rain has provided dilution for the second trip. The results, which will be obtained from samples which will be collected in the future, will shed more light on this phenomenon.

4.1.3 Semi-Volatile Organics

Results of Appendix IX semi-volatile organic analyses are shown on Table 4-4.

The results indicate that only phenolic compounds were detected in the leachate samples. The samples were analyzed for the entire Appendix IX semi-volatile list. Phenol was found at concentrations up to 32 µg/l and was detected in only two of the five leachate samples. It was also detected in each laboratory blank; up to 16 µg/l. Methylphenol compounds (3-methylphenol and 4-methylphenol) were detected in one of the five samples; however, each result was below the instrument detection limit and was, therefore, qualified with a "J," which indicates the value is approximated.

4.1.4 Dioxin

Table 4-5 lists the levels of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofuran (PCDDs and PCDFs) homologs found in the leachate samples collected during Trips Nos. 1 and 2. The 2,3,7,8-TCDD equivalents were calculated according to the EPA Risk Assessment Forum procedures (EPA, 1987) and are listed at the bottom of each column.

Review of the data presented in Table 4-5 indicates that the leachate collected during both trips was essentially free of dioxins. The samples contained only a small fraction of a part per billion of the highest homolog, the octa homolog, which has a toxicity equivalency factor (TEF) of 0.00. One sample (T1L1) also contained 0.222 of the hepta homolog (HPCDD), which has a TEF of 0.001.

TABLE 4-4

LEACHATE SEMIVOLATILE ANALYSES
TRIPS 1 AND 2
WOODBURN SITE

Sample Number:	T1L1	T1L2	T1L3	Laboratory Blank	Laboratory Blank	T2L2	T2L3	Laboratory Blank
Location:	Manhole (1) Standing Liquid	Manhole (1) After Removal of Liquid	Manhole (1) 1 Hour After Liquid Removal			Manhole (1) Immediately After Manhole Refills (20 min.)	Manhole (1) 1.5 Hours After Removing Plug and Manhole Refills (20 min.)	
Matrix: Date Sampled: Date Extracted: Date Analyzed: Units:	Water 02/11/88 02/16/88 02/21/88 µg/L	Water 02/11/88 02/16/88 02/21/88 µg/L	Water 02/11/88 02/16/88 02/21/88 µg/L	Water 02/16/88 02/21/88 µg/L	Water 02/19/88 02/21/88 µg/L	Water 11/29/88 12/07/88 01/03/89 µg/L	Water 11/29/88 12/07/88 01/03/89 µg/L	Water 12/07/88 01/03/89 µg/L
Phenol		19	32		16			6 J
3-Methylphenol			6 J					
4-Methylphenol			6 J					

All Appendix IX semi-volatile compounds were analyzed for but were below detection limits.
Blank space indicates analysis is below detection limits.
J indicates approximate value because contaminants were detected at levels below detection limits.

TABLE 4-5

LEACHATE DIOXIN ANALYSES
TRIPS 1 AND 2
WOODBURN SITE

Sample Number:	T1L1	T1L2	T1L3	Method Blank	T2L2	T2L3	Method Blank
Location:	Manhole (1) Standing Liquid	Manhole (1) After Removal of Standing Liquid	Manhole (1) 1 Hour After Standing Liquid Removal		Manhole (1) Immediately After Manhole Refills (20 minutes)	Manhole (1) 1.5 Hours After Removing Plug and Manhole Refills	
Matrix: Concentration:	Water ppb	Water ppb	Water ppb	Water ppb	Water ppb	Water ppb	Water ppb
2,3,7,8-TCDD							
TCDD-TOT							
PCDD							
HXCDD							
HPCDD	0.222						
OCDD	0.107	0.094	0.057		0.048	0.049	
2,3,7,8-TCDF							
TCDF-TOT							
PCDF							
HXCDF							
HPCDF	0.076						
OCDF							
2,3,7,8-TCDD equivalency ppb	2×10^{-4}	0.00	0.00		0.00	0.00	

Blank space indicates analysis is below detection limit

4.2 SHALLOW SOILS

Shallow soils (0-1 inches deep) were sampled at six locations around the Interim Ash Landfill during Trip No. 1. Sample locations and descriptions are contained in Section 3.0.

4.2.1 Metals

Results of metals analyses for the soil samples are contained in Table 4-6. The background sample (T1S1) provides an indication of soils metal levels at the site area and can be used as a comparative indicator to the soil samples taken around the ash landfill.

The metals analyses indicate that eight of the 11 metals were found above detectable limits in all of the soil samples. Mercury, nickel, and selenium were not present above the detection limit in any of the samples.

The samples surrounding the ash landfill (T1S1 - S5) did not exhibit any significant observable differences in metal concentrations from the background sample (T1S6), with the possible exception of lead. Sample T1S4 had a lead level of 53 µg/g compared to the background sample level of 21 µg/g and an average sample level, excluding T1S4 and T1S6, of 10.4 µg/g. This apparent elevated lead level might be an effect of the sample location, which is between U.S. Route 5 and Frontage Road, both of which receive vehicular emission outfall.

4.2.2 Dioxin

Table 4-7 lists the levels of polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran (PCDD and PCDF) homologs found in the soil samples collected during Trip No. 1. The 2,3,7,8-TCDD equivalents were calculated according to the EPA Risk Assessment Forum procedures (EPA, 1987) and are listed at the bottom of each column.

Review of the data presented in Table 4-7 indicates that the soil samples collected around this ash monofill are essentially dioxin free. The samples contained only a small fraction of 1 part per billion of the 2,3,7,8-TCDD equivalents. The samples containing the somewhat higher levels were collected from locations adjacent to roads, sample T1S4 collected between U.S. Route 5 and Frontage Road, and sample T1S2 collected west of the Access Road. The 2,3,7,8-TCDD equivalency for these two samples was 1.5×10^{-3} and 1.0×10^{-3}, respectively. The 2,3,7,8-TCDD equivalency for the background sample was 1.6×10^{-5} ppb, which was within the range of the rest of the soil samples collected at this

TABLE 4-6

SHALLOW SOILS METALS ANALYSES
TRIP 1
WOODBURN SITE

Sample Number:	T1S1	T1S2	T1S3	T1S4	T1S5	T1S6	Laboratory Blank
Location:	200 Feet North of Ash Pit in Orchard Area	200 Feet West of Ash Pit and West of Access Road	South of New Ash Pit	East of Ash Pit b/w Frontage Road and U.S. Route 5	East of Ash Pit and East of U.S. Route 5	1,000 Feet West of Ash Pit (Background Sample)	
Matrix: Units:	Soil µg/g	Soil µg/g	Soil µg/g	Soil µg/g	Soil µg/g	Soil µg/g	Water µg/L
Arsenic	5.6	9.6	9.6	9.0	9.3	9.9	12
Cadmium	0.19	0.17	0.17	0.15	0.25	0.18	
Chromium	14.0	17.0	21.0	19.0	22.0	19.0	
Copper	8.8	17.0	17.0	9.8	17.0	14.0	
Iron	15,000	26,000	29,000	16,000	29,000	19,000	160
Lead	9.7	10.0	8.9	53.0	13.0	21.0	
Manganese	830	930	770	760	920	680	
Mercury							
Nickel							
Selenium							16
Zinc	72	66	59	47	69	50	41
pH Results	5.3	5.3	5.8	4.7	6.0	5.8	

Blank space indicates analysis result is below detection limit.

TABLE 4-7

SHALLOW SOILS DIOXIN ANALYSES
TRIP 1
WOODBURN SITE

Sample Number:	T1S1	T1S2	T1S3	T1S4	T1S5	T1S6	Method Blank
Location:	200 Feet North of Ash Pit in Orchard Area	200 Feet West of Ash Pit and West of Access Road	South of New Ash Pit	East of Ash Pit b/w Frontage Road and U.S. Route 5	East of Ash Pit and East of U.S. Route 5	1,000 Feet West of Ash Pit (Background Sample)	
Matrix: Concentration: Weight (g):	Soil ppb 13.562	Soil ppb 13.005	Soil ppb 13.527	Soil ppb 13.283	Soil ppb 13.333	Soil ppb 13.699	Soil ppb 10.000
2,3,7,8-TCDD							
TCDD-TOT							
PCDD							
HXCDD	0.008	0.024		0.038			
HPCDD	0.023	0.041	0.008	0.048	0.012	0.013	0.004
OCDD	0.072	0.033	0.013	0.112	0.025	0.026	0.002
2,3,7,8-TCDF							
TCDF-TOT							
PCDF	0.002						
HXCDF	0.003						
HPCDF	0.004				0.003	0.003	
OCDF	0.004				0.002		
2,3,7,8-TCDD eqivalency ppb	5.77×10^{-4}	1×10^{-3}	8×10^{-6}	1.57×10^{-3}	1.5×10^{-5}	1.6×10^{-5}	4.7×10^{-6}

Blank space indicates analysis result is below detection limit.

site, 8×10^{-6} to 5.77×10^{-4} ppb. All samples contained less than the Center for Disease Control (CDC) recommended 2,3,7,8-TCDD level of 1 ppb in soils.

4.3 ASH

Ash samples were collected as described in Section 3.0.

4.3.1 Metals

Results of metals analyses of the ash samples are shown on Table 4-8. The results indicate that all of the metals have been found above detectable levels in each of the four samples with the exception of selenium, which was found in only two of the four samples at levels above the detection limits.

Iron, manganese, zinc, and lead were found at the highest concentrations, averaging 42,000, 2,630, 3,925, and 1,165 µg/g (ppm), respectively. Copper was found at an average concentration of 912 µg/g (ppm). The other metals were at average concentrations lower than 68 µg/g (nickel) or below detectable levels.

Analytical results from Trip No. A1 and Trip No. 2 were comparable for most metals, with the notable exception of cadmium. Trip No. 1A average cadmium levels were 0.51 µg/g compared to 44.5 µg/g in Trip No. 2.

4.3.2 Semi-Volatiles

Ash samples collected during both trips were analyzed for the entire Appendix IX semi-volatile lists. Only three, phthalates, phenol, and acetophenone, were detected in some of the samples. Results are listed in Table 4-9. All results were detected positively but at levels which were below the instrument detection limit and were, therefore, qualified by the analyzing laboratory with a "J." This indicates that the qualified value was only an approximation.

The reagent laboratory blank (for the first trip), contained 62 µg/kg (ppb) of di-n-butyl phthalate, while the two ash samples contained only 53 and 54 µg/kg (ppb) of the same compound. The phthalates are plasticizer compounds and are, therefore, common laboratory contaminants. Thus, the 53 and 54 ppbs were qualified with a "B," indicating that this compound is a laboratory artifact and not an ash constituent.

TABLE 4-8

ASH METALS ANALYSES
TRIPS 1A AND 2
WOODBURN SITE

Sample Number:	T1AW1	T1AW2	Laboratory Blank	T2W1	T2W2	Sample Blank
Location:	Interim Ash Landfill 88 feet North and 163 Feet East of Southwest Corner	Interim Ash Landfill 88 Feet North and 201 Feet East of Southwest Corner		Interim Ash Landfill (Same as T1AW1)	Interim Ash Landfill (Same as T1AW2)	
Matrix: Date Sampled: Date Analyzed: Units:	Ash 05/25/88 06/16/88 µg/g	Ash 05/25/88 06/16/88 µg/g	Water 06/16/88 µg/L	Ash 11/30/88 12/07/88 µg/g	Ash 11/30/88 12/07/88 µg/g	Solid 12/07/88 µg/g
Arsenic	20	146		23	21	
Cadmium	0.54	0.48		42	47	0.06
Chromium	59	54	0.02	74	52	0.6
Copper	630	520		1,400	1,100	
Iron	49,000	35,000	0.06	43,000	41,000	
Lead	1,100	860		1,400	1,300	0.6
Manganese	670	650		5,300	3,900	
Mercury	6.5	12		6.3	7.2	
Nickel	68	40		85	77	
Selenium				23	23	
Zinc	4,200	4,400	0.12	3,000	4,100	
pH	N/A	N/A		7.8	8.3	

N/A No analysis performed.
Blank space indicates analysis result is below detection limit.

TABLE 4-9

ASH SEMIVOLATILE ANALYSES
TRIPS 1A AND 2
WOODBURN SITE

Sample Number:	T1AW1	T1AW2	Laboratory Blank	T2W1	T2W2	Laboratory Blank
Location:	Interim Ash Landfill 88 Feet North and 163 Feet East of Southwest Corner	Interim Ash Landfill 88 Feet North and 201 Feet East of Southwest Corner		Interim Ash Landfill (Same as T1AW1)	Interim Ash Landfill (Same as T1AW2)	
Matrix: Date Sampled: Date Extracted: Date Analyzed: Units:	Ash 05/25/88 06/13/88 06/16/88 µg/kg	Ash 05/25/88 06/13/88 06/16/88 µg/kg	Solid 06/13/88 06/16/88 µg/kg	Ash 11/30/88 12/09/88 01/03/89 µg/kg	Ash 11/30/88 12/09/88 01/03/89 µg/kg	Solid 12/09/88 01/03/89 µg/kg
Phenol	91 J			110 J	110 J	
Acetophenone	66 J			510 J	440 J	
Di-n-butyl phthalate	53 B	54 B	62 J	65 J	73 J	
Butyl benzyl phthalate	67 J					
Bis(2-ethyl-hexyl)phthalate	220 J			360 J	200 J	

All Appendix IX semi-volatile compounds were analyzed for but except for those listed in this table results were below detection limits.
Blank space indicates analysis result is below detection limit.
J - Approximate value because detected at or below detection limit.
B - Laboratory artifact found in laboratory reagent blank.

Review of the data present in Table 4-9 indicates that these ash samples contained very small levels of phenol, acetophenone, and phthalates, which are plasticizer compounds.

4.3.3 Elemental Analyses

Results of elemental analyses of the ash samples are shown on Table 4-10. Figure 4-1 presents the elemental analyses of the MSW combustion ash and includes, for comparative purposes, the elemental analyses of bituminous coal fly ash (DiGioia, Meyers, and Niece, 1977).

Figure 4-1 indicates that silica (S_1O_2), iron oxide (Fe_2O_3) and calcium oxide (CaO) are the principal constituents in the ash. These three compounds account for an average of 61 percent of the ash. The ash unburned carbon, or loss on ignition, was estimated by calculating the remaining percent of constituents not accounted for by the elemental analyses. This remaining percent might include minor amounts of unknown constituents including the trace metal constituents; however, the majority of the unaccounted material is expected to be unburned carbon.

The loss on ignition (LOI) is estimated to average 26.2 percent for the four ash samples. The LOI ranged from 16.9 to 36.3 percent.

Comparison of analytical results from each set of trip samples indicates the variability in ash chemical composition. Significant differences were evident in analyses for iron oxide. Trip No. 1A iron oxide averaged 14 percent compared to a Trip No. 2 average of 8 percent. This variance is not unexpected since considerable metal fragments are present in the ash.

Figure 4-1 indicates that MSW combustion ash is different from typical bituminous coal fly ash with respect to chemical constituents. The primary differences are in the aluminum oxide content (6 percent of study ash versus 23 percent of fly ash) and loss on ignition (26.2 percent of study ash versus 7.5 percent of fly ash).

4.3.4 Dioxin

Table 4-11 lists the levels of polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran (PCDD and PCDF) homologs found in the ash samples collected during Trips No. 1 and No. 2. The 2,3,7,8-TCDD equivalents were calculated according to the EPA Risk Assessment Forum procedures (EPA, 1987) and are listed at the bottom of each column.

TABLE 4-10

ASH ELEMENTAL ANALYSES
TRIPS 1A AND 2
WOODBURN SITE

Sample Number:	T1AW1	T1AW2	T2W1	T2W2
Location:	Interim Ash Landfill 88 Feet North and 163 Feet East of Southwest Corner	Interim Ash Landfill 88 Feet North and 201 Feet East of Southwest Corner	Interim Ash Landfill (Same as T1AW1)	Interim Ash Landfill (Same as T1AW2)
Matrix: Date Sampled: Units:	Ash 5/25/88 Percent	Ash 5/25/88 Percent	Ash 11/30/88 Percent	Ash 11/30/88 Percent
Silica (SiO_2)	43	38	40	36
Iron (Fe_2O_3)	14	14	8.7	7.4
Calcium (CaO)	9.7	11	11	12
Magnesium (MgO)	2.1	1.7	2.3	2.5
Phosphorus (P_2O_5)	<1	<1	N/A	N/A
Sulfur (SO_3)	6.5	7.5	N/A	N/A
Copper (CuO)	<1	<1	N/A	N/A
Aluminum (Al_2O_3)	5.8	6.8	5.5	5.8

N/A No analysis performed.

ACAD: 174M\ASNANAL.DWG

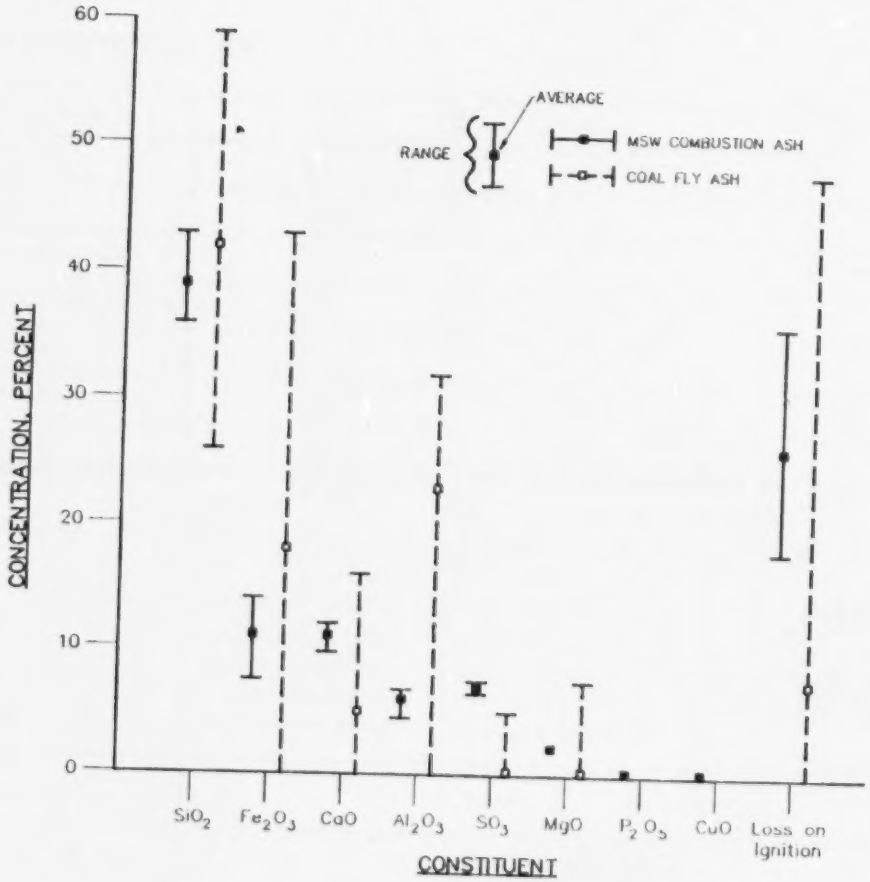


FIGURE 4-1

ELEMENTAL ANALYSES OF MSW COMBUSTION ASH AND COAL FLY ASH
WOODBURN SITE, WOODBURN, OREGON

NUS CORPORATION

TABLE 4-11

ASH DIOXIN ANALYSES*
TRIPS 1A AND 2
WOODBURN SITE

Sample Number:	T1AW1	T1AW2	Method Blank	T2W1	T2W2	Method Blank
Location:	Interim Ash Landfill 88 Feet North and 163 Feet East of Southwest Corner	Interim Ash Landfill 88 Feet North and 201 Feet East of Southwest Corner		Interim Ash Landfill (Same as T1AW1)	Interim Ash Landfill (Same as T1AW2)	
Matrix: Date Sampled: Units:	Ash 05/25/88 ppb	Ash 05/25/88 ppb	Solid ppb	Ash 11/30/88 ppb	Ash 11/30/88 ppb	Solid ppb
2,3,7,8-TCDD		0.006		0.007	0.005	
TCDD-Total	0.020	0.078		0.117	0.139	
PCDD	0.062	0.078		0.099*	0.298*	
HXCDD	0.076	0.802		0.130*	0.643*	
HPCDD	0.239	9.259		0.232*	2.374*	
OCDD	0.394	23.295		0.352	5.315	
2,3,7,8-TCDF	0.031	0.078		0.067	0105	
TCDF-Total	0.231	0.458		0.510	0.801	
PCDF	0.075	0.108		0.158*	0.274*	
HXCDF	0.067	0.166		0.147*	0.274*	
HPCDF	0.050	0.150		0.074*	0.178*	

* The dioxin concentrations listed for these analytes are the total analyte concentrations. The 2,3,7,8 isomers were analyzed for, but not detected.

Blank space indicates analysis result is below detection limit.

Review of the data presented in Table 4-11 indicates that low levels of dioxins are found in these MWC ashes, with the higher homologs being relatively more abundant. The ash samples collected during the second trip were subjected to the analysis of 2,3,7,8 species of each homolog, and the results indicate that the individual 2,3,7,8 species were absent (indicated with * in Table 4-11). The 2,3,7,8 species are the toxic species and are those that should be avoided in the environment. The 2,3,7,8-TCDD equivalency ranged between 1.06×10^{-1} to 4.61×10^{-2} ppb, all below the recommended CDC the action level of 1 ppb for residential soils

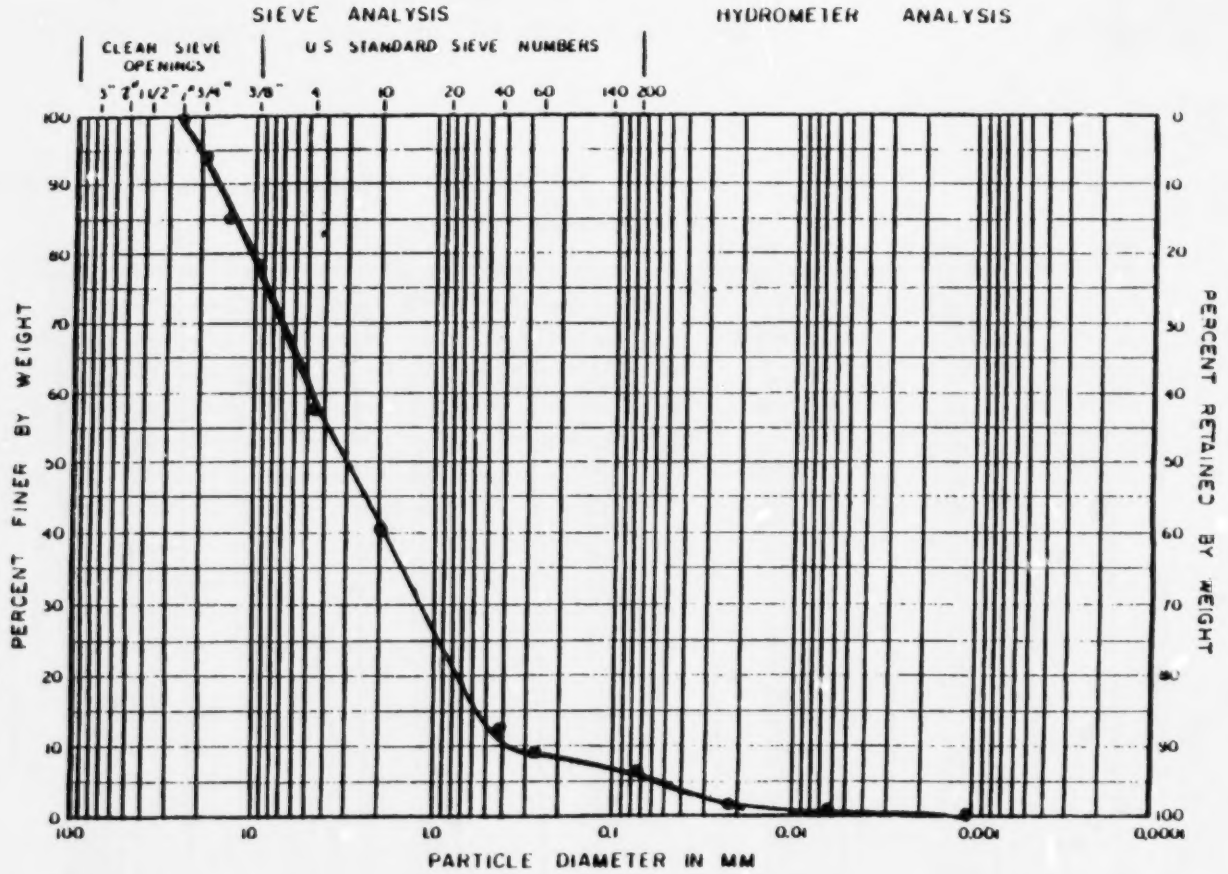
4.3.5 Grain Size Distribution

Grain size and hydrometer analysis were performed on four ash samples taken from the Interim Ash Landfill during the two separate site trips. In each case the ash samples were manually sorted to remove particles larger than approximately 1 inch in size.

The results of the grain size analyses are shown on Figures 4-2 to 4-5.

The soils classification appropriate for each ash sample is gravelly sand with silt. The percent of the sample finer than the No. 200 sieve, or the fine silt and clay fraction, ranged from 6 to 10 percent of the sample weight.

There was no apparent difference between the grain size distribution exhibited by the ash samples collected during the two trips.

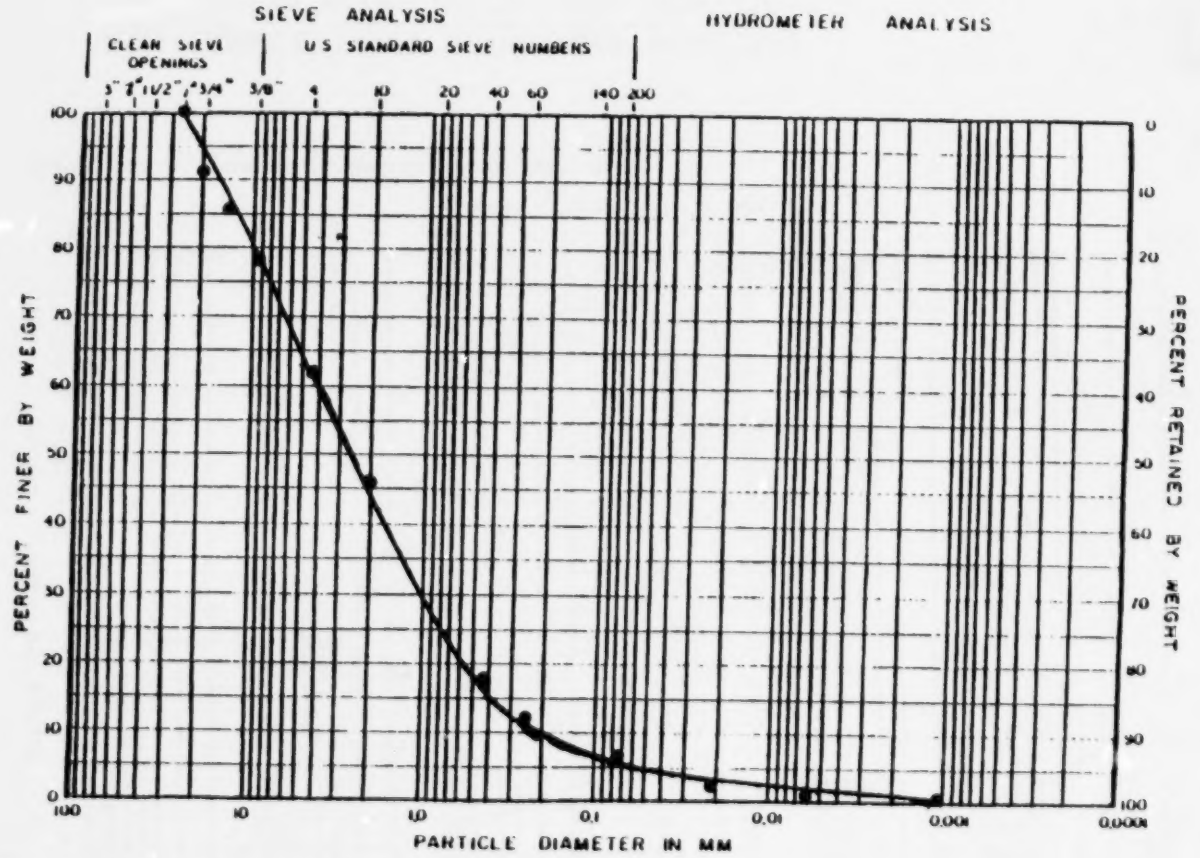

SIEVE ANALYSIS
HYDROMETER ANALYSIS
CLEAR SIEVE OPENINGS
U S STANDARD SIEVE NUMBERS
3" 2" 1 1/2" 1" 3/4" 3/8" 4 10 20 40 60 140 200
PERCENT FINER BY WEIGHT
PERCENT RETAINED BY WEIGHT
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
100 10 1.0 0.1 0.01 0.001 0.0001
PARTICLE DIAMETER IN MM

UNIFIED SOIL CLASSIFICATION: GRAVELLY SAND WITH SILT

FIGURE 4-2

ASH SAMPLE T2W1 GRAIN SIZE ANALYSIS
WOODBURN SITE, WOODBURN, OREGON

NUS CORPORATION

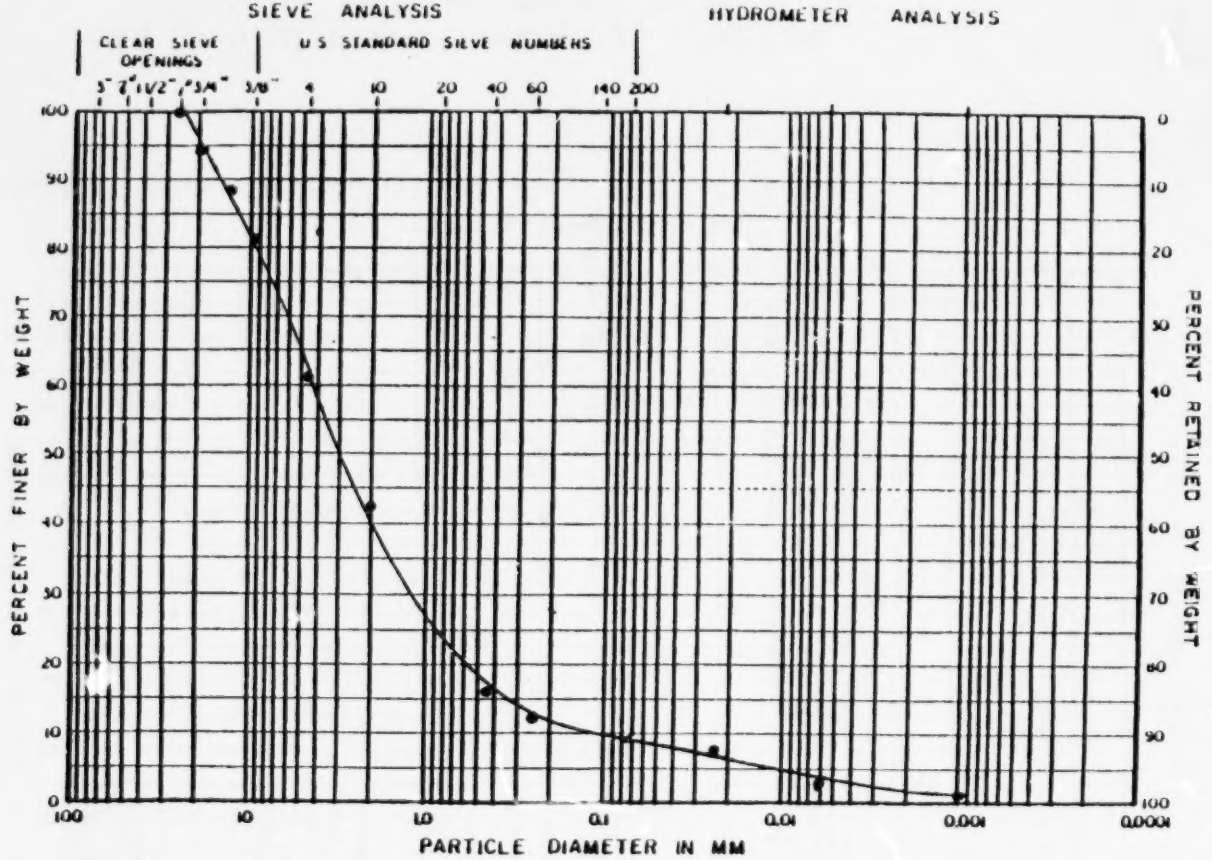

SIEVE ANALYSIS
HYDROMETER ANALYSIS
CLEAR SIEVE OPENINGS
U S STANDARD SIEVE NUMBERS
3" 2" 1 1/2" 3/4" 3/8" 4 10 20 40 60 140 200
PERCENT FINER BY WEIGHT
PERCENT RETAINED BY WEIGHT
100 90 80 70 60 50 40 30 20 10 0
100 10 1.0 0.1 0.01 0.001 0.0001
PARTICLE DIAMETER IN MM

UNIFIED SOIL CLASSIFICATION: GRAVELLY SAND WITH SILT

FIGURE 4-3

ASH SAMPLE T2W2 GRAIN SIZE ANALYSIS
WOODBURN SITE, WOODBURN, OREGON

NUS CORPORATION

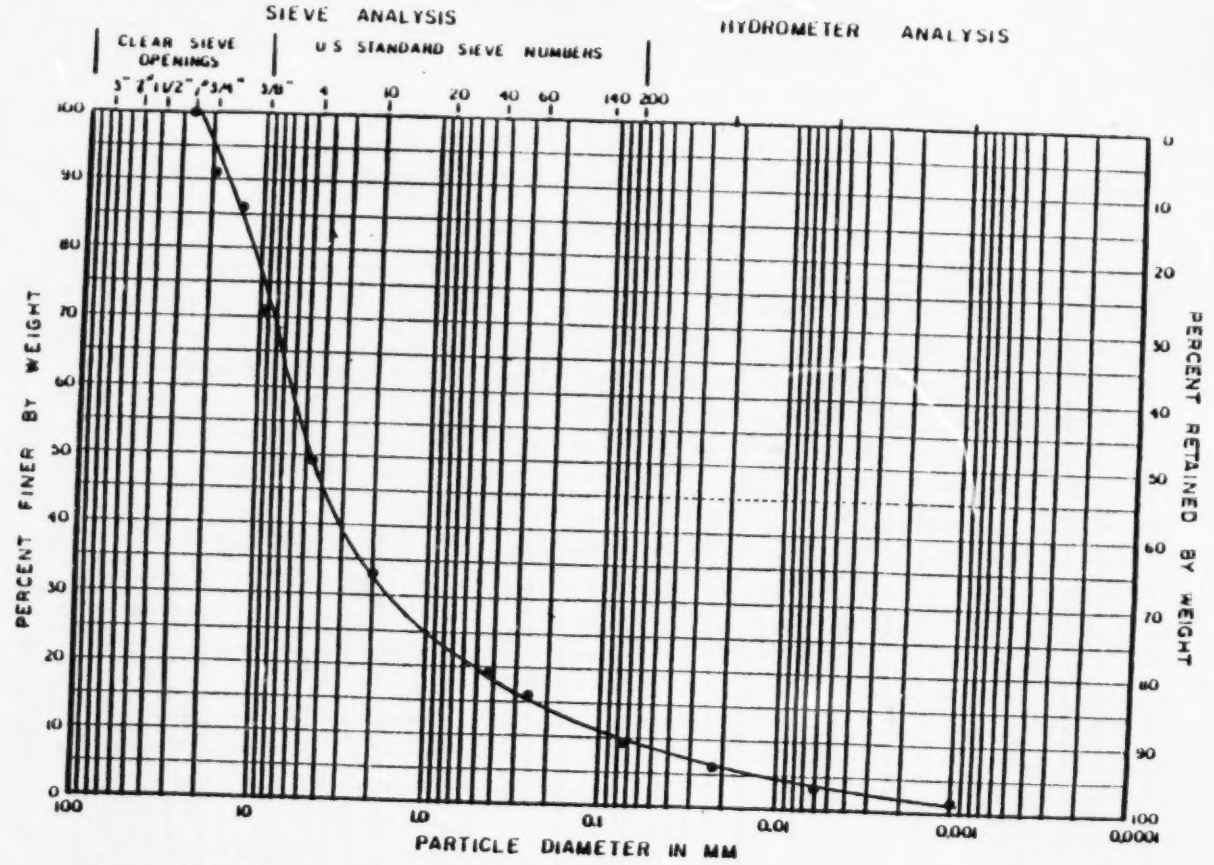

SIEVE ANALYSIS
HYDROMETER ANALYSIS
CLEAR SIEVE OPENINGS
U S STANDARD SIEVE NUMBERS
5" 3" 1 1/2" 3/4" 3/8" 4 10 20 40 60 140 200
PERCENT FINER BY WEIGHT
PERCENT RETAINED BY WEIGHT
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
100 10 1.0 0.1 0.01 0.001 0.0001
PARTICLE DIAMETER IN MM

UNIFIED SOIL CLASSIFICATION: GRAVELLY SAND WITH SILT

FIGURE 4-4

ASH SAMPLE TIAWI GRAIN SIZE ANALYSIS
WOODBURN SITE, WOODBURN, OREGON

NUS CORPORATION


SIEVE ANALYSIS
HYDROMETER ANALYSIS
CLEAR SIEVE OPENINGS
U S STANDARD SIEVE NUMBERS
3" 2" 1 1/2" 1" 3/4" 3/8" 4 10 20 40 60 140 200
PERCENT FINER BY WEIGHT
PERCENT RETAINED BY WEIGHT
100 90 80 70 60 50 40 30 20 10 0
PARTICLE DIAMETER IN MM
100 10 1.0 0.1 0.01 0.001 0.0001

UNIFIED SOIL CLASSIFICATION: GRAVELLY SAND WITH SILT

FIGURE 4-5

ASH SAMPLE T1AW2 GRAIN SIZE ANALYSIS
WOODBURN SITE, WOODBURN, OREGON

NUS CORPORATION

5.0 SUMMARY AND CONCLUSIONS

This baseline report contains leachate, ash and soil characterization data obtained from the first baseline year. During this baseline year, 1988, two trips were conducted during which leachate, ash, and soil samples were collected from the Woodburn Monofill.

The Woodburn Monofill, located in Marion County, Oregon, was selected as the suitable site to provide the needed long-term characterization data of leachates generated from the monofill, of the ashes aging in the monofill, and of the surrounding soils affected by airborne dust from the ash monofill.

Samples collected from this site were analyzed for conventional parameters, metals, the entire semivolatile list on Appendix IX and dibenzo-p-dioxins and dibenzofurans to the homolog levels. All sampling activities and analytical protocols adhered strictly to the QAPP requirements, as approved by the EPA.

The major findings of this study are as follows for the leachates:

- The major constituent in the leachate samples collected from this site, is salt. This agrees with data available from other sites. The Total Dissolved Solids (TDS) levels ranged from approximately a third to somewhat higher than the levels found in sea water. The main salt constituents in these leachates are chloride, sulfate and sodium.

- The leachate has elevated concentrations of total organic carbon (TOC) and ammonia-nitrogen. The presence of these constituents indicate that uncombusted organic matter remains in the ash and anaerobic biodegradation may be occurring.

- All metal concentrations in all leachate samples were below the EP-toxicity Maximum Allowable Limits.

- The leachate samples were essentially free of dioxins.

- The leachates contained essentially no semivolatile compounds on the Appendix IX list.

For soils the major findings were as follows:

- To date, the soils in the vicinity of this ash-monofill have not been affected by the airblown ash dust from the monofill. The soil samples were essentially free of dioxins and semivolatile compounds on the Appendix IX list. These soil samples did not contain metal levels beyond the levels found in the site background sample. Those samples collected from locations close to roads, which are subject to vehicular emission effects, contained somewhat higher lead levels than the site background sample. The samples located close to roads also contained somewhat higher levels of dioxins. All samples levels of dioxin were below one part per billion which is the level recommended by the CDC for residential soils.

For the ash samples the major findings were as follows:

- The ash samples contained metals.
- The ash samples contained low levels of phenolic and phthalate compounds.
- The ash samples contained low levels of dioxins. However, the 2,3,7,8-TCDD equivalency of these samples did not reach the CDC recommended limit for residential soils of 1 ppb.

Studies to be conducted in years to come at this site will provide data on time trends for the ash, the leachates, and the soils. Some data gaps will be closed and answers to important questions regarding the heterogenicity of the ashes, the varying levels of TDS in the leachates and the verification of the existence of anaerobic conditions in ash monofills may be obtained.

6.0 REFERENCES

Chian, E. S. and F. B. DeWalle, September, 1977. Evaluation of Leachate Treatment, Vol. I, Characterization of Leachate, EPA 600/2-77-186a.

DiGioia, A. M., J. F. Meyers, and J. E. Niece, June 1977. Design and Construction of Bituminous Fly Ash Disposal Sites. Proceedings of ASCE (American Society of Civil Engineers) Geotechnical Speciality Conference.

Hem, J. D., 1986. Study and Interpretation of the Chemical Characteristics of Natural Water. U.S.G.S. Water Supply Paper 2254.

Russ Fetrow Engineering, 1988. Geotechnical Study, Woodburn Landfill.

U.S. EPA (U.S. Environmental Protection Agency), March 1987. Risk Assessment Forum: "Interim Procedures for Estimating Risks Associated With Exposure to Mixtures of Chlorinated Dibenzo-p-dioxins and Dibenzofurans (CDDs and CDFs)." EPA/625/3-87/012.

U.S. EPA (U.S. Environmental Protection Agency), October 1987. Characterization of MWC Ashes and Leachates From MSW Landfills, Monofills, and Co-disposal Sites, EPA 530-SW-87-028A, Office of Solid Waste.

U.S. EPA (U.S. Environmental Protection Agency), June 1988. Addendum to Characterization of MWC Ashes and Leachates From MSW Landfills, Monofills, and Co-disposal Sites Office of Solid Waste.

APPENDIX A

FIELD LOGBOOK DATA

Municipal Solid Waste (MSW)
Combustion Residue Pit
Woodburn, Oregon

Contract No 68-01-7310

Site Directions

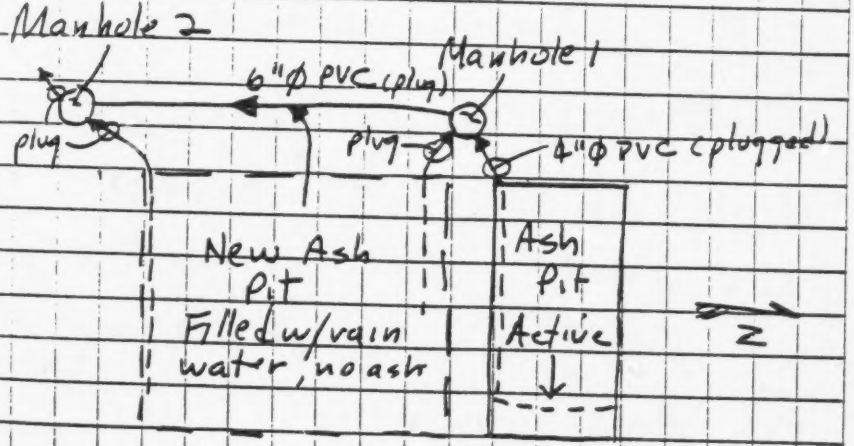
I-5 South from Portland,
Exit 271 - Woodburn,
Right on Rt 214, approx.
100 yards, turn right
at Texaco, follow signs
to Ash landfill

TITLE RCRA Woodburn, Ore. PROJECT NO. Y950
Trip 1 BOOK NO. 1

February 11, 1988
Weather: Overcast, fog, ~50°F

8:10 M. Dowiak
Tom Riley
Charles Moench, EPA HWERL
onsite to set up sampling
of leachate, shallow soils
(Work Plan Trip 1).
Tim Delagowski, Marion Co.

Site conditions:



Manhole 1 ~ 2' Freeboard, leachate and rainwater that leaks from plugged lines.

SIGNATURE M. Dowiak DATE 2-11-88
WITNESS DATE

TITLE

PROJECT NO.

BOOK NO.

Sample Log:

Time	Location	Containers	Analyses
February 11, 1988			
10:00	TIL1	(2) 1/2 gal Amber	PCDD/PCDF
		(2) 1/2 gal Amber	Appendix IX semi-volatiles
		1 liter PE	Metals
		1 liter PE	$N\text{-}NH_3$
			TKN
			TOC
		1 liter PE	SO_4, Cl.

Field Conductivity ~ 10,000 micromhos/cm

Field PH - not working

Temperature - Ambient (~ 55°F)

Description - Black, sulfide-odor strong

2

SIGNATURE M Donnelly DATE 2-11-8

WITNESS DATE

TITLE

PROJECT NO. Y950
BOOK NO. 1

Manhole 2 - Freeboard - 0"
rainwater and dilute leachate
leakage from plugged liner

8:40 Called H. Roffman to confirm
sample locations
Proposed points: (4)
TIL1 - Manhole 1 standing water
TIL2 - Manhole 1 inflow from
4" ϕ PVC drain - ash pit
immediately after plug is
removed
TIL2 same as TIL2 but
indicate MS-MSD (for
matrix spike and matrix
spike duplicate)
TIL3 - Manhole 1 inflow
from 4" ϕ PVC drain - ash pit,
1 hour after TIL2.

H. Roffman says OK!

10:00 Sample TIL1 from Manhole 1
bib drain. Flush drain ~ 5gal
prior to sampling

SIGNATURE M. Doucak | DATE 11-88 | 3
WITNESS | DATE

TITLE

PROJECT NO.

BOOK NO.

Sample Log

Time	Location	Containeus	Analyses
10:45	TIL2	same as TIL1 plus (1) extra set duplicate for Matrix Spike - Matrix Spike Duplicate (MS-MSD)	
	Field Conduc.	> 10,000 u mhos/cm	
	Field PH	Not working	
	Temp.	24.8°C	
	Description:	Clear, slightly colored grey, sulfide odor - mild	
11:30	TIL3	same as TIL1	
	Field Conduc.	No reading	
	Field PH	Not working	
	Temp.	NR	
	Description:	Clear, greyish, with fine black suspended solids sulfide odor - mild	

4

SIGNATURE M. Donnelly DATE 2-11-8[illegible]

WITNESS DATE

TITLE

PROJECT NO. Y950
BOOK NO. 1

10:15 Marion Co. starts pump to drain MH 1
Plug removed.
Refill rate: (4'ϕ MH)

Time	Freeboard
0	7'-0
70 sec.	6'-4 1/2"
(~ 50 gpm)	

10:45 Sample TIL2 from Manhole 1 with stainless steel bucket

Marion County personnel start pump to remove standing water (~ 3' Freeboard) in MH 1
Refill rate (4'ϕ MH)

Time	Freeboard
0	8'-0
1 min	7.75'
2 "	7.15'
3 "	6.60'
4 "	6.05'

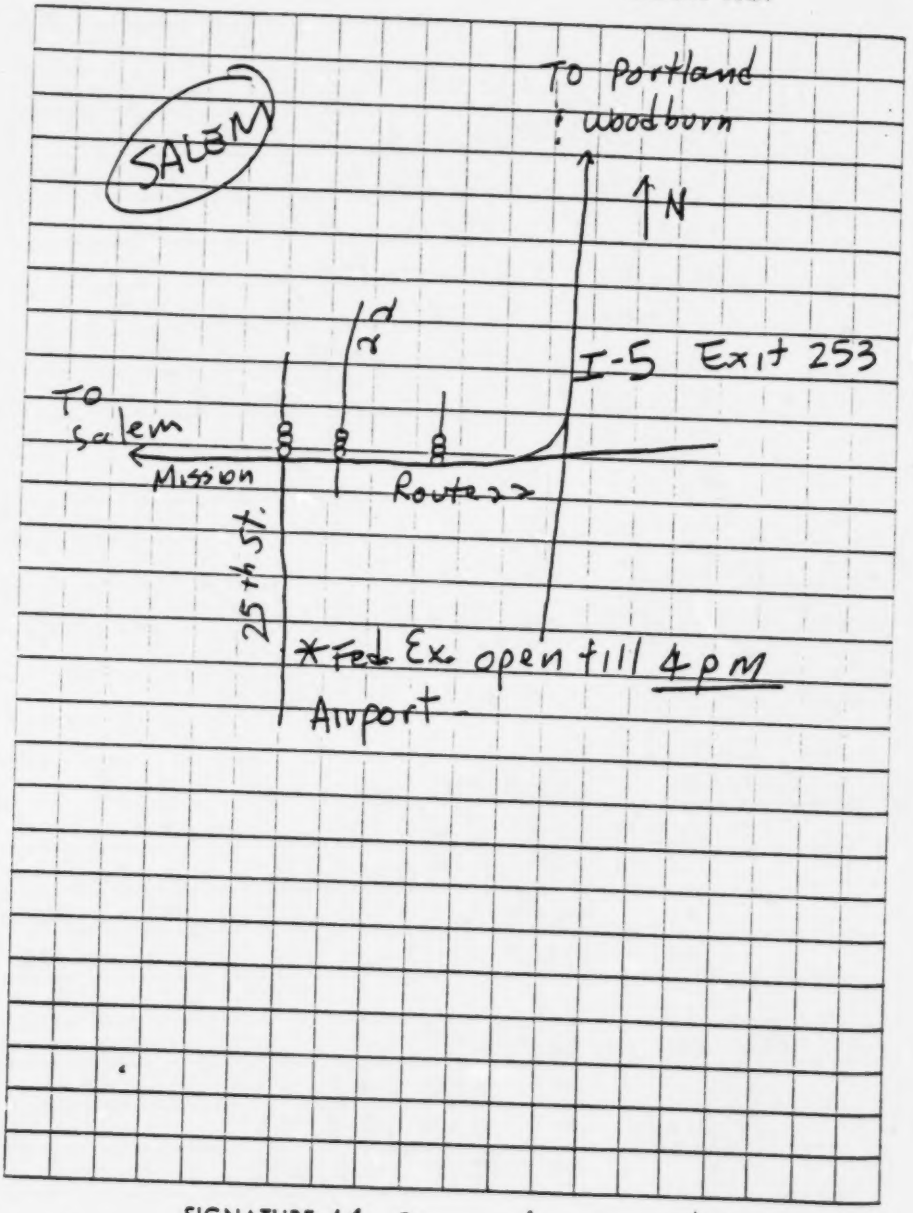
11:30 Sample TIL3 from Manhole 1 with Stainless steel bucket

SIGNATURE M. Durak | DATE 2-11-88
WITNESS | DATE

TITLE

PROJECT NO.

BOOK NO.



6

SIGNATURE M. Darnell

WITNESS

DATE 11-88

DATE

TITLE

PROJECT NO. Y950
BOOK NO. 1

12:30 NUS/EPA leave site for Federal Express, Salem. (See Map opposite page) and to obtain HNO_3 for sample preservation (Fisher, Seattle, backordered acid, will be delivered to Marion Co., c/o J. Seavs, in future).
HNO_3 obtained at Salem Willow Island Municipal Treatment Plant, Mr. Keith Chapman, Lab Supervisor 503-588-6380
Spec: Baker 9998-2.
HNO_3 70-71%.

4:00 pm Samples shipped to 3 labs: via Fed. Ex overnite.
S³ - San Diego - 1 cooler
Battelle - Columbus - 1 cooler
NUS - Pittsburgh - 1 cooler

Fed. Ex. Airbill Nos.:
S³ - 715748174
Battelle - 715748163
NUS - 715748161 2

SIGNATURE M. Daniels | DATE 2-11-88
WITNESS | DATE

7

TITLE

PROJECT NO.

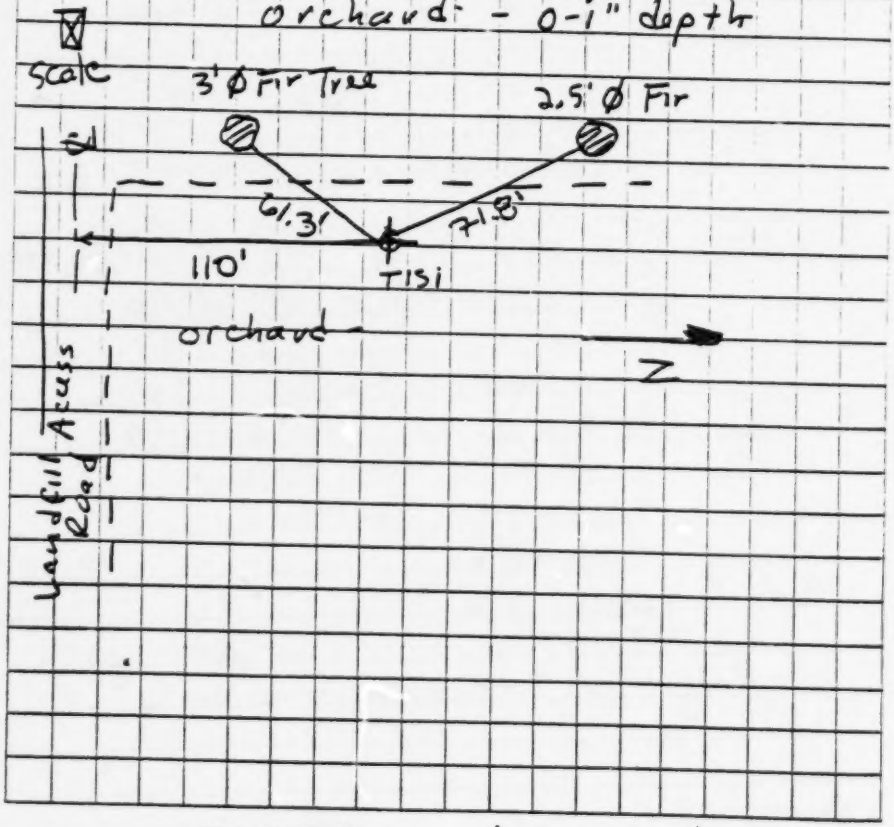
BOOK NO.

Sample Log

Time		Containers	
1120	TIS1	(1) 80z glass	PCDD/PCDF
		(1) 80z glass	Metals

Description - Brown organic silt

Location: North of Ash Pit in orchard - 0-1" depth



8

SIGNATURE M. Dennehy DATE 2-12-00

WITNESS DATE

TITLE RCRA Woodburn PROJECT NO. Y950
BOOK NO. 1

February 12, 1988
Weather: Overcast fog ~ 45°F

7:00 M. Dowiak, T. Riley @ Holiday Inn on telephone to NUS Pgh.

C. Moench @ Holiday Inn.

10:15 Onsite
M. Dowiak, T. Riley - NUS
C. Moench, USEPA HWERL
T. Delagowski, Marion Co.

11:20 Sampled TI51 - 0-1" soil depth. removed surface vegetation

Sampled TI52 to TI56
See Sample Logs - pps. 9, 10-12
14:30 Left site for Federal Express - Portland Airport
Fed Ex. Airbill NOS
53 - 715 7481623 1 cooler (small)
Battelle - 715 7481634 1 cooler (")

SIGNATURE M. Dowiak DATE 2-12-88
WITNESS DATE

TITLE

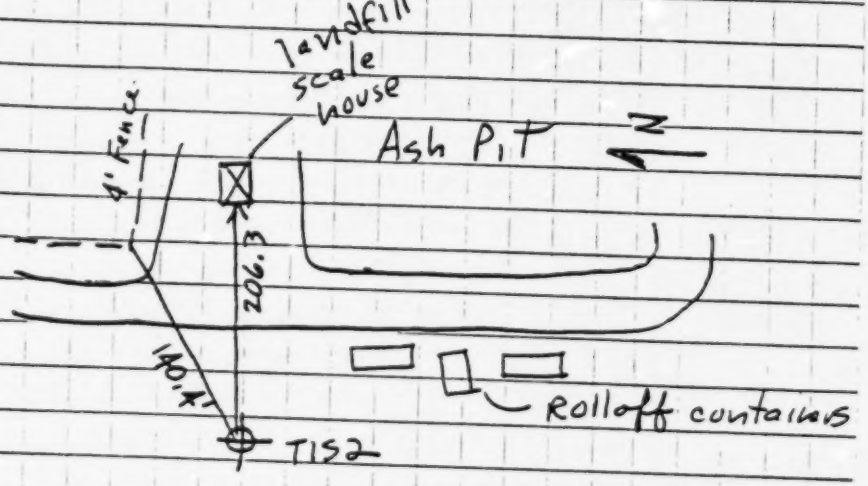
PROJECT NO.

BOOK NO.

Sample Log

Time

1200 T1S2. Containers same as T1S1



Description: Brown organic silt (base)
Location: West of ash pit

12:20 T1S6 same as T1S1

Description: Brown, organic silt
Location - "Background"
50' North of monitoring well 23C
(~1000' west of ash pit)

SIGNATURE M. Daraki DATE 2-12-88

WITNESS DATE

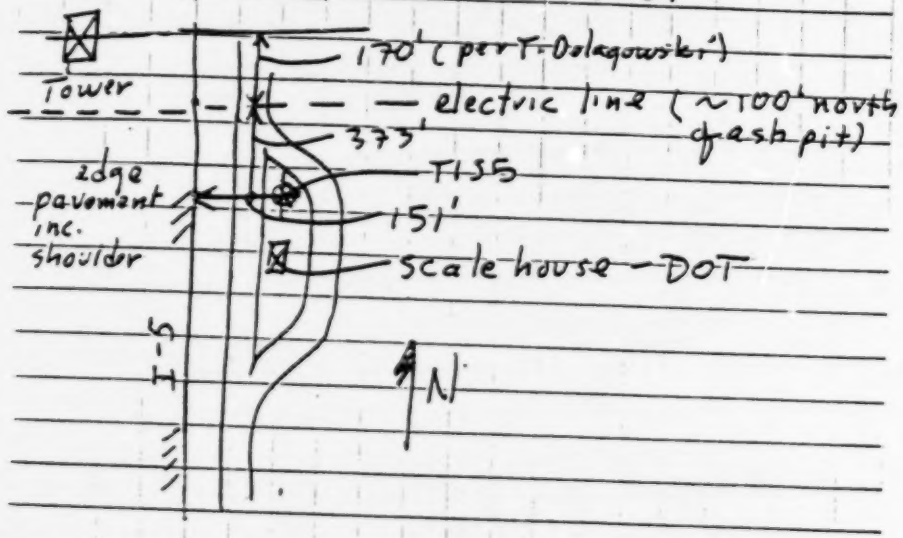
TITLE

PROJECT NO. 7950
BOOK NO. 1

Sample Log

Time Contained

1400 T155 same as T151



Description: Brown organic silt, some sand; fine gravel. vegetated (removed)

Location: East of I-5 and at ~ ¢ of ash pit, in grassed area of truck weighing facility

SIGNATURE M. Daniels DATE 2-12-88

WITNESS DATE

11

TITLE

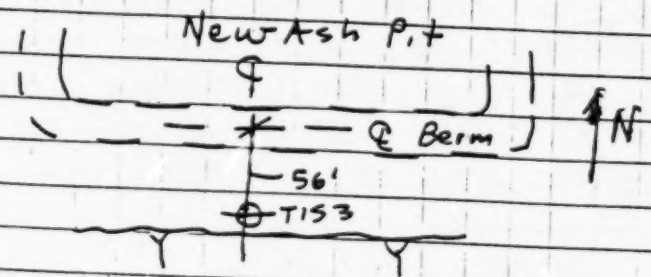
PROJECT NO.

BOOK NO.

Sample Log

Time Location Containers

1250 T153 same as T151



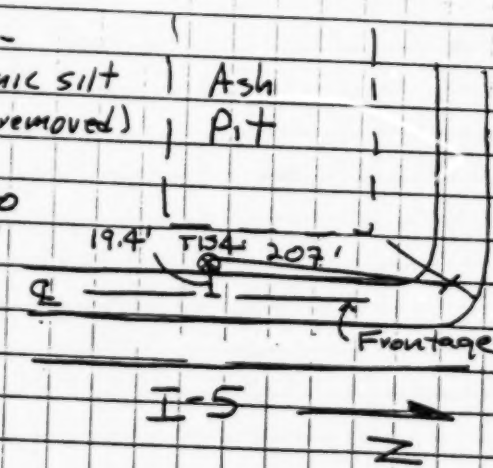
Description: Brown organic silt - bare

Location: South of new ash pit

1300 T154 same as T151

Description -
Brown, organic silt
vegetated (removed)

Location -
Adjacent to
Frontage Rd
on west
side



SIGNATURE M. Dannels DATE 2-12-88

WITNESS DATE

TITLE

PROJECT NO. Y950
BOOK NO. 1

2-12-88

Note: Marion Co., Tim Delagowski, indicated he would store preservatives H_2SO_4 and HNO_3 (which received from F-shoy, Seattle) at county offices for future NUS use

SIGNATURE M. Durnal | DATE 2-12-88

WITNESS | DATE

TITLE

PROJECT NO.

BOOK NO.

5-25-88 Trip 1A

8:20 Arrive @ Site
Meet Tim D.

8:30 Remove top Layer from existing P.T

8:35 Take Samples FROM T1AW1
@ Depth of 5ft

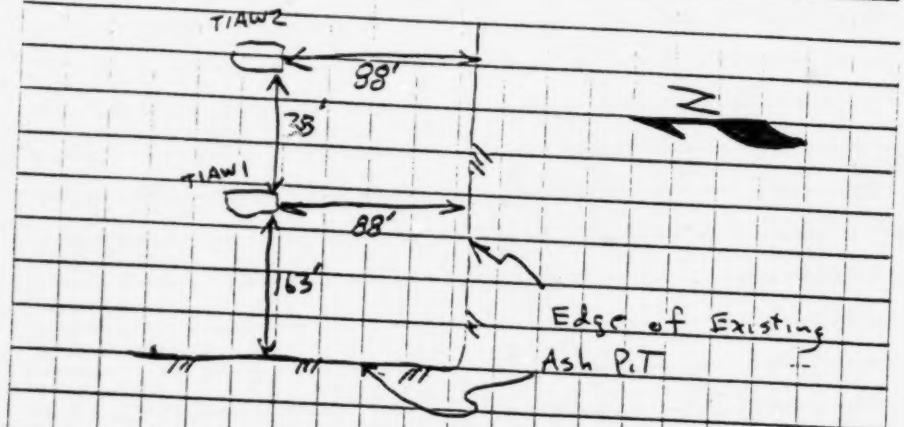
Note:

~~T1W.A~~

T1AW1 = West P.T

T1AW2 = East P.T

8:55 TAKE SAMPLES FROM T1AW2
@ Depth of 5ft



14

SIGNATURE [signature] DATE 5-25-88

WITNESS DATE

TITLE

PROJECT NO.

BOOK NO.

10:15 Samples logged and packaged. Leave for Fed-x Portland Airport.

11:30 Samples Shipped to three seperate Labs via Fed-x overnight.

Airbill Nos.-

Battelle -325758064

S-Cubed -325758086

NUS (LSD) -834886935 3

SIGNATURE [signature] DATE 5-25-88

WITNESS DATE

TITLE RCRA Woodburn Trip 2. PROJECT NO.. BOOK NO.

November 29, 1988
Weather: Partly sunny, mild, ~50°F

8:20am M. Dowiak on site to set up sampling Trip 2 for leachate and ash w/ Tim Delagowski, Marion Co.

Notes - continuous light rainfall for previous 30 days

New ash pit dry - no standing water. no ash fill in new pit
Manholes 1 and 2 piping is plugged as in Trip 1 (see page 1).
Manhole 1 freeboard ~ 8 ft.
1 no.
Sample T2L1 - Manhole №1 standing water, not taken per instructions from H. Roffman.

9:30 Sampled T2L2 from Manhole №1 after plug to ash pit (old) is removed and manhole refills, to approximately 5 ft freeboard.

SIGNATURE M. Dowiak DATE 11-29-88
WITNESS DATE

TITLE

PROJECT NO.

BOOK NO.

Sample Log

Time	Location	Containers	Analyses
10:00 am	T2L2 (leachate)	(1) 1 l PE	metals
		(1) 1 l PE	TOC/NH_3
		(1) 1 l PE	TDS, NO_3, SO_4, PO_4
		(1) 500 ml PE	CO_3
		(2) 1/2 gal Amber	PCDD/PCDF
		(2) 1/2 gal Amber	Semi-VOAs

Field Cond. - no instrument available
Field PH - 7.3
Field Temp - 13.2° C
Description - Cloudy, gray, w/ suspended solids - no discernable odor

11:30 am T2L3 <Same as T2L2>
T2L3 - Matrix Spike - Matrix Spike Dup.
(leachate) <Same analyses as T2L2>
Note: M. Dowiak shipped T2L3 MS-MSD w/semi-VOA and PCDD/PCDF. These analyses are not in the proposed Trip 2 plan.
11-30 called H. Roffman to delete analyses

18

SIGNATURE M. Dowiak | DATE 11-29

WITNESS | DATE

TITLE

PROJECT NO.

BOOK NO.

Sample Log cont.

I2L3 -

Field Cond. - no instrument available

Field PH - 7.9

Field Temp. - 19°C.

Description - Slightly cloudy, few suspended solids - no discernable odor

Note: I2L3 is apparently leachate drained from ash, and not from drain pipe

SIGNATURE M. Daniels | DATE 11-29-88

WITNESS | DATE

19

TITLE

PROJECT NO.

BOOK NO.

11.30 am Sampled T2L3 from Manhole Nº 1 approximately 1½ hrs after sampling T2L2 Manhole Nº 1 freeboard approximately 6 ft

Note: SCS engineers onsite at 9:00 am to retrieve ~500 gallons of leachate from Manhole Nº 1 after sample T2L2 and before sample T2L3. This assumes T2L3 is leachate drained from ash and not drain lines

11:30 - 2:00 Completed sample labeling and documentation and proceeded to Federal Express, Salem (see p. 61

4:00 Shipped (3) packages to (3) separate labs via Fed. Exp overnite; Salem Airport Airbill Nos.

NUS c/o J. Simanic - 863 3806 333
Battelle c/o T. Dewald - 863 3806 311
S³ c/o B. Blackburn - 863 3806 322

SIGNATURE M. Donnelly DATE 11-29

WITNESS DATE

TITLE

PROJECT NO.

BOOK NO.

November 30, 1988
Weather: Dense Fog, cool. ~35°F

9:30 am - Arrived onsite
Received Fed. Exp. overnite delivery of extra 1 quart glass containers

10:00 am Sampled Ash Pit by backhoe excavation to 5 ft. depth @ previous sample locations TIAW1 and TIAW2 (See pg. 14)
No additional ash fill on these sample locations since 5-88 Trip 1A

Note: Sample areas subject to repeated passes of 10 ton ash trucks for unloading on east edge of pit. This probably causes some compaction of upper layers of ash fill, however, the upper 18 inches of the test pits were less dense than lower 3½ feet. Apparently, truck and equipment compaction is not a significant factor in ash fill densification.

SIGNATURE M. Demark | DATE 11-30-88

WITNESS | DATE

TITLE

PROJECT NO.

BOOK NO.

Sample Log

Time	Location	Containers	Analyses
10:00am	T2W1 (ash)	1 Q glass	Metals (c) and Semi-VOAs
	(88'N, 163'E from SW corner of pit)	1 Q glass	Metals (d) and TOC, NH_3, NO_3, SO_4, PO_4, CO_3, Cl, PH, Salts
		1 Q glass	PCDD/PCDF
		2-Ziploc bags 1 Gal	Grain Size

Metals (c) - As, Ba, Cd, Cr, Pb, Hg, Se, Ag Cu, Mn, Zn

Metals (d) - Al, Si, Ca, Mg, K, Fe, Na.

Field PH- 1/2 Quart Ash mixed with 1/2 Quart tap water (PH. 7.6) — 9.1

Field Temp - 19°C - Thermometer in base of test pit (avg. of 3 locations), ± 1°C

Description - Dark gray, Silt with sand and gravel size particles

Upper 18 inches - loose, poorly cemented

Lower 3 1/2 feet - v. dense, stiff CL

22.

SIGNATURE M. Dowiak — DATE 1-30

WITNESS — DATE

TITLE

PROJECT NO.

BOOK NO.

Sample Log, cont.

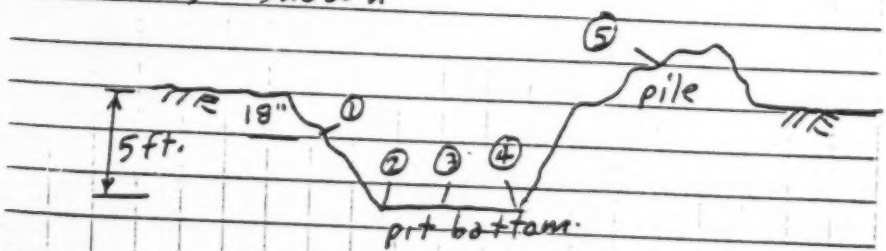
T2W2 (ash)
(88'N, 201'E from SW corner of pit) — same containers and analyses as T2W1

Field pH - Same method as T2W2 - pH 8.9

Field Temp. - 18°C (avg. of 3 locations in pit bottom) ± 1°C

Description - Same as T2W1.

Note: Ash samples are composites from (5) locations in pit as shown:



Typical Test Pit Section

SIGNATURE M. Dowiak

DATE 11-30-88

WITNESS

DATE

TITLE

PROJECT NO.

BOOK NO.

Note - EQUIPMENT

(1) Cooler left onsite in shed next to scale house (per Tim Delagowski, Marion Co.)

Contents:

* (1) Jar H_2SO_4 acid
* (1) Jar HNO_3 acid
(1) box 10 large trash bags
(1) box 20 1 Gal ziplocs
~100 ft PE rope
(1) box of 6-1/2 Gal Amber glass bottles (80 oz)

Custody sealed on 11-30-88 by M. Dowiak

SIGNATURE M. Dowiak | DATE 11-30-88

WITNESS | DATE

TITLE

PROJECT NO.

BOOK NO.

3:00pm Shipped (3) packages to (3) separate labs via Fed. Express overnite, Salem Airport. Airbill Nos

NUS c/o J. Simanic 863 3806 230
S3 c/o B. Blackburn 241
Battelle c/o J. Dowold 252.

SIGNATURE M. Dennis DATE 11-30-88

WITNESS DATE